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14. ABSTRACT

The U.S. Army Research Institute of Environmental Medicine (USARIEM) was tasked by the U.S. Army Training and Doctrine Command (TRADOC) to develop criterion-based physical requirements for entry into the seven physically demanding combat MOSs. Researchers from USARIEM completed three studies to develop a valid, safe, and legally defensible physical performance battery to predict a Soldier's ability to serve in each MOS. Data from 877 complete datasets were used in the development of three courses of action for gender neutral Occupational Physical Aptitude Tests (OPATs): Test Battery 1: medicine ball put, squat lift, beep test, standing long jump, arm ergometer; Test Battery 2: medicine ball put, squat lift, beep test, standing long jump; Test Battery 3: standing long jump, 1- minute push-ups, 1- minute sit-ups, 300m sprint, Illinois agility test. Test Batteries 1 and 2 have adequate and similar predictive power, while that of Test Battery 3 has a much lower predictive power. Factoring in the cost, equipment, and time, USARIEM's recommendation would be to implement Test Battery 2.

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USARIEM TECHNICAL REPORT T16-2

DEVELOPMENT OF THE OCCUPATIONAL PHYSICAL ASSESSMENT TEST (OPAT) FOR COMBAT ARMS SOLDIERS

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FOREWORD

This Technical Report is the final in a series documenting the development of a physical performance screening test for employment in the seven Combat Arms Military Occupational Specialties (MOSs) as part of the Soldier 2020 initiative. Prior reports were written for the studies of Combat Engineers (12B, (8)), Field Artillery (13B, 13F, (7)), Infantry (11B, 11C, (24)) and Armor (19D, 19K, (6)) MOSs. This final report was written to develop one overarching test battery to cover all seven MOSs. This test battery has acceptable predictive capability to identify candidates for each of the seven MOSs.

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LIST OF ACRONYMS

AIT	Advanced Individual Training
APFT	Army Physical Fitness Test
BCT	Basic Combat Training
BFV	Bradley Fighting Vehicle
CMTS	Criterion Measure Task Simulations
FAASV	Field Artillery Ammunition Supply Vehicle
HE	High Explosive
HR	Heart Rate
MEPS	Military Entrance Processing Station
MOS	Military Occupational Specialty
MPAT	Multi-Purpose Anti-Tank
OPAT	Occupational Physical Assessment Test
OSUT	One Station Unit Training
PPE	Personal Protective Equipment
RPE	Rate of Perceived Exertion
SME	Subject Matter Expert
TRADOC	Training and Doctrine Command
USARIEM	U.S. Army Research Institute of Environmental Medicine
VO_2	Oxygen Uptake

BACKGROUND

Soldiers in the Combat Arms are required to do a number of physically demanding jobs, which require high degrees of muscular strength, muscular power, muscular endurance, aerobic capacity, and agility. Presently, the only way that the Army assesses a Soldier's physical readiness for duty is through the Army Physical Fitness Test (APFT). A number of studies have shown, however, that this score is not highly correlated with the performance of the physically demanding tasks performed by Soldiers (13, 19). Furthermore, the APFT score includes adjustments for age and sex, not only biasing for/against certain groups, but making it potentially legally indefensible if used as a screening tool for entrance into certain MOSs (10). Since it is not practical to test Soldiers performance of physically demanding tasks prior to entering an MOS, criterion-based physical performance tests (i.e., tests that are predictive of soldiering task performance) are essential if the Army wishes to establish valid standards to select Soldiers for an MOS.

The U.S. Army Research Institute of Environmental Medicine (USARIEM) was tasked by the Training and Doctrine Command (TRADOC) to develop a new criterion-based physical testing procedure for entry into seven physically demanding Combat Arms MOSs. The seven Combat Arms MOSs are: 11B Infantryman, 11C Infantryman-Indirect Fire, 12B Combat Engineer, 13B Cannon Crewmember, 13F Fire Support, 19D Cavalry Scout, and 19K Armor Crewman. This is tasking resulted from the lifting of the Army direct ground combat exclusion by the former Secretary of Defense (Leon Panetta), which will require the services to open these MOSs to females or justify the decision to keep them closed.

In order to develop standards for the seven Combat Arms MOSs, TRADOC developed a list of 32 physically demanding tasks relevant to these seven MOSs. USARIEM then conducted three research studies. Study 1 involved measuring and identifying the physiological requirements of each of the tasks. From these data, a set of criterion tasks were developed, which encompass the physiological demands of all of the tasks. Study 2 involved determining the reliability of these criterion tasks. Finally, once reliable criterion tasks were developed, test batteries using cost, space, and time-effective prediction tests were developed in Study 3 for screening entrants into the MOS. The results of each MOS study are provided in separate technical reports (6-8, 24). The purpose of this report is to develop a single occupational physical assessment test to cover all seven Combat Arms MOSs.

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DISCLAIMERS

Portions of this technical report have been previously reported (6-8, 24).

The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or as reflecting the views of the Army or the Department of Defense.

The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219.

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EXECUTIVE SUMMARY

Currently, Soldiers in the U.S. Army are not selected for their MOS (Military Occupational Specialty) based on their ability to perform the physical tasks necessary for that MOS. The U.S. Army Research Institute of Environmental Medicine (USARIEM) was tasked by the U.S. Army Training and Doctrine Command (TRADOC) to develop criterion-based physical requirements for entry into the seven physically demanding combat MOSs. Researchers from USARIEM completed three studies to develop a valid, safe, and legally defensible physical performance battery to predict a Soldier's ability to serve in each MOS. Each MOS was studied individually to produce an optimized physical performance battery for that MOS. Data from 877 complete datasets were used in the development of the test batteries. In depth job analysis revealed that five of the seven MOSs (11B, 11C, 12B, 13F, 19D) had similar critical physically demanding tasks, while two MOSs (13B and 19K) had additional or different tasks with heavy physical demands. In order to reduce costs, simplify and streamline testing, additional analyses were run to determine if a common battery of physical performance tests could be used for all seven MOSs without a large loss in the predictive capability.

Based on the data from these studies, three courses of action for gender neutral Occupational Physical Assessment Tests (OPATs) were developed for seven combat MOSs.

- Test Battery 1: medicine ball put, squat lift, beep test, standing long jump, arm ergometer
  Includes upper and lower body power, muscle strength, muscle endurance and aerobic capacity assessments with R^2=0.80-0.85 predictive power and 87-90% correct identification.
- Test Battery 2: medicine ball put, squat lift, beep test, standing long jump
  Includes upper and lower body power, muscle strength and aerobic capacity assessments and utilizes easily accessible equipment with R^2=0.79-0.81 predictive power and 85-90% correct identification.
- Test Battery 3: standing long jump, 1-minute push-ups, 1-minute sit-ups, 300 m sprint, Illinois agility test
  Includes only lower body power, muscular endurance, and agility assessments, with R^2=0.58-0.71 predictive power and 81-82% correct identification.

Two of the test batteries have a very high level of predictive power. If implemented the OPAT would improve the selection of Soldiers physically qualified for Combat Arms MOSs.

Recommendations:

Test Batteries 1 and 2 have adequate and similar predictive power, while that of Test Battery 3 has a much lower predictive power. Factoring in the reduced cost, equipment and time required to implement Test Battery 2 vs. Test Battery 1, USARIEM's recommendation would be to implement Test Battery 2.

Note: Prior technical reports were written for the Combat Engineer, Field Artillery, Infantry and Armor MOSs. This final report was written to develop a single test battery to cover all seven MOSs.

INTRODUCTION

Pre-employment test batteries are becoming more common for entry into militaries across the globe. Physical employment test batteries have been (or are currently being) developed by the Armed Forces of Australia (21), Canada (4, 5), and the United Kingdom (22, 23) (Appendix A). Predictor tests range from those highly faithful to the original task, such as the weight load march and jerry can carry of the Australians (2), to much simpler tasks, such as static lift and 1.5 mi run from the U.K. (3, 22). These physical employment test batteries were developed using a research approach similar to the strategy outlined by Payne & Harvey (20), which is currently accepted as the best paradigm for development of pre-employment screening tests. A similar approach was taken in the development of test batteries presented in this report.

TRADOC began by reviewing field manuals, training videos and physical task descriptions related to each of the MOSs in order to identify the most physically demanding tasks. A group of subject matter experts (SMEs) from each of the proponent schools then developed a task list and associated minimum standards based on this review. The result was a list of 32 physically demanding tasks relevant to these MOSs (Table 1). Of these tasks, nine were common to several MOSs and 23 were specific to one or two MOSs. TRADOC then observed Soldiers of each MOS performing the tasks. If 90% of the Soldiers observed could not perform the tasks to standard, the task statements were revised until the 90% threshold was reached. As part of this TRADOC exercise, USARIEM researchers also observed the Soldiers. Quantifiable task details were recorded including quantity and weights of loads being moved or lifted, distances traveled, Soldier gear, and equipment required.

For the next phase of the study, USARIEM researchers conducted focus groups with enlisted Soldiers from each MOS. Both lower enlisted (Corporal/Specialist and below) and upper enlisted (Sergeant through Sergeant First Class) Soldiers completed surveys about each of the tasks identified as relevant to their MOS. Soldiers were asked how often they completed the tasks in training and while deployed in order to the better understand the frequency of performing the task. This was followed with a face-to-face focus group session where Soldiers were asked about the details collected during phase one, such as if the weights and distances were correct, and if there were any additional tasks which warranted consideration (16).

USARIEM researchers then completed three studies of Soldiers performing the physically demanding tasks prior to development of the final test battery. Data from these studies are presented in prior technical reports (6-8, 24). During the first study, USARIEM researchers measured the physiological demands of each of the 32 physically demanding tasks identified by TRADOC. Some of the tasks were not collected due to either a large skill component (as the hand grenade throw) or the duplication of the physical demands with another task (multiple foot marches). Measurements of time to complete, ratings of perceived exertion (RPE), heart rate (HR), and oxygen consumption (VO_2) were recorded. From these data a set of 2 to 6 of tasks for each MOS were identified as capturing all of the most physically demanding aspects

of that MOS (Table 2). A total of eight tasks captured the physical demands of all seven MOSs.

Once the eight tasks were identified, it was necessary to develop criterion measure task simulations (CMTS). These CMTS had to meet a number of requirements. The simulations must assess individuals, not teams. Thus, any tasks involving more than one person needed to be deconstructed into a single person task. The CMTS must allow for a range of scores to show differences between Soldiers and cannot simply be a pass/fail. Each simulation should measure unique physical capabilities, be safe and easy to administer, and require minimal skill or learning. In order to test large numbers of Soldiers, the simulation (as much as possible) should require minimal and available equipment and be time efficient. Most importantly, the simulations need to be reliable. That is, the same Soldier must get the same score every time they test. USARIEM created and tested eight CMTS and determined their reliability by having a set of 50 Soldiers complete each test four times over the course of two weeks. A summary of these reliability values are provided in Appendix B (6-8, 24).

The final step was to select a set of basic physical tests to predict performance on the CMTS. Basic physical predictor tests measure one or more physical abilities (e.g., muscular strength). It is not usually an efficient use of time and resources to have new recruits perform the exact task to determine physical readiness or success in an MOS. For example, devoting a Bradley Fighting Vehicle (BFV), or even a mock BFV, for physical assessment in a Military Entrance Processing Station (MEPS) would take up a large amount of space, and would likely pose a risk of injury to the recruit. The use of basic predictor tests to assess a Soldier's physical capabilities is better suited for these purposes. While we previously identified predictor tests for each individual MOS, a single Occupational Physical Assessment Test battery (OPAT) would simplify the accessions process going forward. Thus, the purpose of this report is to describe the development an OPAT which would cover all seven MOSs.

METHODS

Data were collected from a total of 877 Soldiers during five data collections over the course of one year: Ft. Hood, TX (July 9-18, 2014), Ft. Carson, CO (February 23-March 13, 2015 and April 6-20, 2015), Ft. Stewart, GA (May 26-June 9, 2015), and Ft. Riley, KS (June 21-27, 2015). Soldiers were briefed on all of the tasks prior to consenting. Following consent and screening, participating Soldiers were asked to complete an information sheet that contained demographics and task performance history. Anthropometrics were also collected prior to testing.

Soldiers completed all of the CMTS relevant to an MOS as well as all of predictor tests. Male Soldiers held the MOS being tested, while the females were from any MOS. Prior to testing, Soldiers given at least two practices on the CMTS were determined to have a learning effect: stow ammo on an Abrams, transfer ammo on a FAASV, and load the main gun.

TESTING OVERVIEW

Testing consisted of the two to six criterion tasks and up to 15 predictor tests. A summary of the tests completed by each MOS cohort is provided in Table 2. For a detailed explanation of the testing procedures for each MOS, consult the MOS specific technical reports (6-8, 24). Soldiers were placed in squads and completed all testing as part of that squad. Prior to each test, Soldiers were briefed and familiarized with the procedures.

TESTING PROCEDURES

Criterion Measure Task Simulations:

Descriptions and standards of the eight CMTS are provided below. Standards used to estimate pass rates were provided by either the Office of Chief of Infantry (foot march) or TRADOC G3/5/7 (all other tasks).

Foot March (11B, 11C, 12B, 13F, 19D, 19K)

Conduct a Tactical Movement

The foot march simulation required Soldiers to complete a movement of 4 mi, while wearing the basic Soldier uniform, personal protective equipment (PPE) including a simulated weapon, and a 24-hour sustainment load (approximately 103 lb). Soldiers were instructed to complete the task as quickly as possible while walking on a supervised course. Running and the 'airborne shuffle' were not allowed. Soldiers were allowed to take breaks as needed. Soldiers were instrumented with a timing chip (SPORTident Model SIAC1, Arnstadt, Germany). Time to completion was recorded.

Standard: 1 h 47 min (based on an 80% of the 4 km/hr (~2.49 mi/hr) standard, with the final 20% improvement achievable with pre-mission training)

Sandbag Carry (11B, 11C, 12B, 13F, 19D)

Prepare a Fighting Position

Soldiers lifted and carried 16 sandbags weighing 40 lb while wearing a fighting load minus the weapon (approximately 71 lb). Sandbags were carried 10 m and placed on the floor in a 4 long x 2 deep x 2 high position as quickly as possible. Time to complete the task was collected.

Standard: 16 min (based on 26 min to move 26 sandbags standard)

Move Under Fire (11B, 11C, 12B, 13F, 19D, 19K)

Move Under Direct Fire

During this task, Soldiers wore a fighting load (approximately 83 lb) and carried a simulated weapon at the ready. Soldiers began the task in the prone position. Upon command, Soldiers sprinted approximately 6.6 m to a marker and assumed the predetermined position for that marker (either a kneeling or prone position). They remained in this position for 5 s. Upon signal, Soldiers got up, sprinted to the next marker and assumed the next predetermined position for that marker. The order of the positions was kneel, kneel, prone. This was repeated

until the Soldier had sprinted a total of 100 m (15 rushes). The course is diagramed in Figure 1. Soldiers were instructed to run through the finish line. Time to complete the task was recorded.
Standard: as fast as possible (all Soldiers who complete the task are considered passing)

Casualty Evacuation (11B, 11C, 12B, 13F, 19D, 19K)
Casualty Evacuation from a Vehicle

This task was simulated using a platform with a hole designed to simulate the hatch of a BFV or M1 Abrams. In order to standardize conditions, which would be impossible using a standard dummy with limbs that may catch in an irregular manner, the simulated casualty used for this task was a haul bag (Black Diamond Zion, Salt Lake City, UT) modified to include straps that simulate the shoulder straps of a Combat Vehicle Crewman protective vest. The bag was placed in the hole with the handles of the bag level with the platform (see Figure 2).

Prior to initiating the task, each Soldier practiced proper lifting technique using a pair of kettlebells. Then on the platform, while wearing a fighting load minus the weapon (approximately 71 lb), Soldiers squatted and grasped the handles of the heavy bag, then stood up and pulled the bag through the hole in the platform. Soldiers were required to place the heavy bag onto the platform for successful task completion. An initial load of 50 lb was used for additional familiarization and warm-up. With the successful completion of each lift, the weight of the simulated casualty was increased in 10-, 20-, or 30-lb increments. Following at least 3 min of rest at the higher loads (>80% one repetition maximum), the process was repeated until the Soldier reached volitional fatigue, failed to lift the bag during two consecutive attempts, or a maximum load of 210 lb was reached. The maximum load represented the weight of an average Soldier wearing a Vehicle Crewman Uniform. If Soldiers were not able to lift the bag following an increment of more than 20- or 30 lb, the Soldier was allowed to test on the skipped weights (i.e., 10- or 20 lb less than the failed attempt). The maximal load was recorded.
Standard: 103.5 lb (based on 1/2 of 2-person 207-lb lift standard)

Casualty Drag (11B, 11C, 12B, 13B, 13F, 19D, 19K)
Drag a Casualty to Immediate Safety

Soldiers dragged the simulated casualty (approximately 270 lb) 15 m as fast as they could in 60 s (30 s for Ft. Hood testing) while wearing a fighting load with a weapon (approximately 83 lb). For the simulated casualty, a Survivor dummy (Dummies Unlimited, Pomona, CA) was modified to obtain the necessary weight (Figure 3). If the Soldier failed to pull the casualty 15 m in the allotted time, the distance the casualty was dragged was measured. A rubber flooring (4' x 6' x 3/4" Interlocking Diamond Plate Tiles, Kodiak Sports, Plano, TX) was used as a standardized surface for testing. Scores were calculated as the velocity (m/s) at which the dummy was moved.
Standard: 0.25 m/s, or 15 m in 60 s

Transfer Ammo with a FAASV (13B)

Transfer Ammunition with an M992 Field Artillery Ammunition Supply Vehicle (FAASV)

While wearing approximately 49 lb of task specific equipment, each Soldier had 21 minutes to move thirty M795 HE Rounds (approximately 100 lb each) from the floor of the FAASV into the designated locations on the ammunition rack inside the FAASV. The highest point on the rack that the Soldier was required to place the round was equal to shoulder height. Soldiers were given openings lower on the rack to make up for any that were above their shoulder height (see Figure 4). The 21 min were broken up into three 5-minute active loading periods with two 3-minute rest periods. Time to complete the task (not including the 3-minute rest period) was recorded. If the Soldier was actively moving a round at the end of the 5-minute active loading period, he or she was asked to put it down, and during the next active period the Soldier started from where the round was placed.

Partial credit was given for a round that was not fully emplaced. One third of a round was awarded for lifting the round, two thirds for moving it to the bustle rack, and full credit was awarded when the whole round was emplaced in the bustle rack. The rate of loading (rounds/min) was calculated either by dividing 30 rounds by the elapsed time (if all rounds loaded before time expired) or by dividing the number of completed rounds by 15 min (if not all rounds were loaded).

Standard: 2 rounds/min or (30 rounds in 15 min)

Load Main Gun (19K)

Load the 120mm Main Gun on an Abrams Tank

While wearing 49 lb of task specific equipment, Soldiers loaded five 120mm MPAT rounds (approximately 55 lb each) into a simulated breach of the Abrams tank main gun as quickly as possible (diagram in Figure 5). Prior to testing, Soldiers were briefed on proper technique and provided an opportunity to practice. Soldiers then completed the task three times. Time to complete the task was recorded and the fastest two trials were averaged.

Standard: 5 rounds in 35 s

Stow Ammo (19K)

Stow Ammunition on Abrams Tank

While wearing a fighting load minus the weapon (approximately 71 lb), Soldiers moved 18 120 mm MPAT rounds (approximately 55 lb each) from a rack simulating an ammunition point onto a platform simulating the deck of an Abrams tank (diagram in Figure 6). This platform was 5 m away from the ammunition rack and required a 64-inch lift. A detail Soldier was waiting at the platform to receive the round. Time to complete the task was recorded, and a rate (rounds/min) of loading the rounds was calculated. If a Soldier was unable to complete the task within 15 min or chose to stop, the rate was calculated as the number of rounds completed divide by 15 min.

Standard: 1.8 round/min or 18 rounds in 10 min (based on 36 rounds in 20 min standard)

Predictor Tests:

Fifteen simple predictor tests were administered. The loaded step test was administered only at Ft. Hood with the 12B cohort, but was dropped because it was time intensive and showed little predictive potential. Three additional tests were added in its place: squat lift, resistance pull, and powerball throw. The 15 predictive tests were:

Isometric Biceps Curl (upper-body strength)

Soldiers stood on a wooden platform holding onto a bar with palms facing up, elbows at a 90° angle and forearms parallel to the floor. The bar was attached to a chain attached to the platform, and an inline dynamometer with a force display recorded force production. On command, they pulled upward on the bar maximally for 3 to5 s. If there was more than a 10% difference in the three scores, they were given up to two additional trials. The highest two trials within 10% of each other were averaged to determine an overall score (26).

Upright Pull (lifting strength)

Isometric strength of the muscle groups involved in lifting was assessed by the 38 cm upright pull. The Soldier assumed a squatting position with their buttocks against a wall, head and shoulders up and arms extended, while grasping the handle of the dynamometer in a mixed grip. On command, the Soldier pushed down by extending the knees and pulled up by extending the hips to exert maximum force on the handle. The peak force produced was recorded. Soldiers were given a minimum of three trials, with about 1-minute rest in between each trial. If there was more than a 10% difference in the three scores, they were given up to two additional trials. The highest two trials within 10% of each other were averaged to determine an overall score (14).

Squat Lift (lower-body strength)

Soldiers lifted pairs of weights (dumbbells) ranging from 25 to110 lb (total weight: 50 to 220 lb). The Soldiers were provided instructions on proper lifting technique prior to beginning the test. Beginning by standing with their feet shoulder-width apart, Soldiers squatted and grasped the handles of the weights at their sides, and performed a squat lift. A warm-up weight of 50 lb (two 25-lb dumbbells) was used for three lifts and coaching was provided to ensure safe lifting technique. For testing, the weight started at 60 lb and increased by 20 lb (10 lb per dumbbell) with at least 1-minute of rest between trials. The test continued until the Soldier could no longer lift the dumbbell with proper lifting technique or they reached the maximum weight of 220 lb. The maximum weight lifted was recorded.

Handgrip (strength)

Soldiers held a handgrip dynamometer (Jamar Plus+, Sammons Preston, Bolingbrook, IL) in their hand, with the elbow at a 90° angle and at the side of the

body. The handle of the dynamometer was adjusted such that the base rested on first metacarpal (heel of palm), while the handle rested on middle of four fingers. When ready, Soldiers squeezed the dynamometer with maximum isometric effort for about 3 to5 s. No other body movements were allowed. Three trials were given for each hand. The highest two trials (kg) on each side were averaged and the sum of the two hands recorded (1).

Medicine Ball Put (upper-body power)
Soldiers sat with their back firmly against a chair placed against a wall, while holding a 2-kg medicine ball with both hands. On command, the Soldier touched his/her chest with the ball and pushed the ball upward and outward at a 45° angle for maximum distance. The distance between the landing point and the front of the chair was measured. Soldiers were given two practices and three attempts. If there was more than a 10% difference in the two highest scores, they were provided up to two additional trials. The average of two furthest distances (cm) of the three attempts calculated and recorded (12).

Standing Long Jump (lower-body power)
Soldiers stood behind a line marked on a mat with parallel and shoulder width apart. A 2-foot take-off and landing was used, with swinging of the arms and bending of the knees to provide forward drive. Soldiers attempted to jump as far as possible, landing on both feet without falling backwards. Three attempts were allowed. The two furthest distances jumped (cm) were averaged and recorded (15).

Resistance Pull (lower-body power)
Soldiers held a 24-kg kettlebell attached to a fixed resistance of 100 lb and pulled it for 20 m and/or 90 s, whichever came first. The resistance was provided by an Exer-Genie Trainer (Exer-Genie, Inc., Thousand Oaks, CA) or a plate loaded sled (Magic Carpet Sled, Spud, Inc., Columbia, SC) on the rubber flooring described in the casualty drag. Soldiers were instructed to pull on the kettlebell attached to the rope while stepping backwards as quickly as possible. A maximum time limit of 90 s was set. If the Soldier failed to pull the load a distance of 20 m in the 90 s allotted time, the distance completed was measured and recorded. Time to complete and distance were recorded, converted to speed (m/s).

300 Meter Sprint (speed/lower-body power)
Soldiers ran 300 m around a track as quickly as possible. Prior to testing, Soldiers were allowed time to warm up and stretch. Times (min) were collected using a stopwatch.

Powerball Throw (whole body power)
The Powerball Throw test required throwing a 20-lb medicine ball for a maximum distance to measure total body power. Soldiers began the test by standing with

their heels on the starting line and facing the opposite direction in which the ball would be thrown. They held the ball with both hands, and while keeping their arms extended, brought the ball down between their legs with bent knees. In one motion, they threw the ball up and back over their head. The distance from the starting line to the point at which the ball landed was measured. Soldiers completed two practice throws and three trials for record. If there was more than a 10% difference in the two highest scores, they were provided up to two additional trials. If Soldiers stepped backwards over the throwing line from which the throw distance was measured prior to releasing the ball, the trial was repeated. The average of two furthest distances (cm) was used for analysis (27).

Arm Ergometer Test (upper-body endurance)
Soldiers cranked an arm ergometer (Model 881E, Monark AB, Varberg, Sweden) as fast as possible for 2 min. The workload was fixed at 50 watts. Soldiers were in a kneeling position facing the arm ergometer with the center crank adjusted to shoulder height. The total number of revolutions was recorded (9, 10).

One Minute Push-up (upper-body muscular endurance)
The push-up test used the same rules as the APFT (28) with the exception that the test was only 1 minute in duration. Briefly, Soldiers began with their arms straight, hands a comfortable distance apart, and body straight. Soldier's feet could be up to 12 inches apart. On the command 'go,' the push-up was started by bending elbows and lowering the body until the upper arms were at least parallel to the ground. Soldiers then returned to the starting position. Soldiers performed as many push-ups as possible in one minute.

One Minute Sit-up (core endurance)
The sit-up test used the same rules as the APFT (28) with the exception that the test was only one minute in duration. Briefly, Soldiers began by lying on their back with the knees bent at a 90° angle. Their feet could be up to 12 inches apart and were held down by a second individual. Soldier's fingers were interlocked behind their head. On the command 'go,' the sit-up was started by raising the upper body forward to or beyond the vertical position (meaning that the base of the neck is above the base of the spine), and then the body was lowered until the bottom of the shoulder blades touched the ground. Soldiers performed as many sit-ups as possible in one minute.

Beep Test (aerobic capacity)
Soldiers continuously ran between two lines 20 m apart in time to recorded beeps. Soldiers began by standing behind one of the lines facing the second line. When instructed by a recording, they began running at a slow pace. Soldiers continued running between the two lines, placing at least one foot over the opposite line and turning when signaled by the recorded beeps. After each minute, a tone indicated an increase in speed, and the beeps became closer together. If the line was not reached before the beep sounded, the Soldier was given a warning and continued to run to the line, turn and try to catch up with the

pace within two more 'beeps'. The test was stopped when the Soldier failed to reach the line for two consecutive beeps after a warning. The total number of shuttles completed was recorded (18).

Loaded Step Test (aerobic capacity)
Soldiers stepped up and down on a 12-inch step in time to a metronome sounding at a rate of 120 bpm. Four counts were used to complete a full up and down motion (up, up, down, down) for a stepping rate of 30 steps per minute. A fighting load of about 83 lb was worn. Soldiers stepped up and down at 30 cycles/min for 5 min or until they failed to keep the pace for two consecutive cycles. Endurance time (min) was recorded (17).

Illinois Agility Test (agility)
The length of the course was 10 m and the width (distance between the start and finish points) was 5 m. Four cones were used to mark the start, finish and the two turning points. Another four cones were placed down the center an equal distance apart. Each cone in the center was spaced 3.3 m apart (See Figure 7). Soldiers began by lying prone (head to the start line) with their hands by their shoulders. On the 'go' command, the stopwatch was started, and the Soldier got up as quickly as possible and ran around the course in the direction indicated, without knocking over the cones. Time to complete the course was recorded (11).

All testing instructions and data collection sheets can be found in Appendices C and D, respectively.

STATISTICAL ANALYSES

Descriptive statistics were calculated for performance on all of the CMTS and predictor tests. CMTS scores were converted to Z-scores in order to create a common scale for all criterion tasks. Z-scores for the timed CMTS (foot march, sandbag carry, move under fire, and load main gun) were inverted (i.e., multiplied by -1) so that better scores were greater numbers. For each individual, the Z-scores for all CMTS of their MOS were summed to create a total CMTS score. Multiple linear regression using forward stepwise procedures were used to produce equations and test batteries predicting the total CMTS score. Each test battery used the predictor tests to predict performance on the CMTS. Following validation testing for the 12B MOS, the move under fire task was added to their critical task list. Since the criterion tasks of the 12B were the same as the 11B, 11C, 13F, and 19D and data from the 12B was not significantly different from those MOSs for the remaining 4 CMTS, the 12B data were not used in development of the test battery. However, the 12B data were used for test battery validation.

Three test batteries were developed to provide several courses of action depending on the availability of funding and equipment. These batteries were developed by entering different subsets of predictor tests into the analyses: one all possible predictive tests, one without any calibrated equipment, and one with only

predictor tests which require a stopwatch and tape measure. Each test battery was first developed to identify significant predictors of the five MOSs with a common set of criterion tasks (11B, 11C, 12B, 13F, 19D). Then, separate stepwise regression analyses were run on the 13B and 19K, forcing in the predictors identified in the previous regression, in order to determine if any of the remaining predictor tests significantly added to the predictive power for those two MOSs.

Finally, two sets of secondary analyses were performed. One identified the predictive ability of each test battery for the individual CMTS. The second estimated the accuracy of the model based on performance standards for the criterion tasks (which were vetted by TRADOC). Soldiers were classified as either a true pass (Soldier completed all CMTS to standard, and the OPAT predictive test battery correctly classified the Soldier as passing), true fail (Soldier did not complete all CMTS to standard, and the OPAT predictive test battery correctly classified the Soldier as failing), false pass (Soldier did not complete all CMTS to standard, and the OPAT predictive test battery incorrectly classified the Soldier as passing) or false fail (Soldier completed all CMTS to standard, and the OPAT predictive test battery incorrectly classified the Soldier as failing). Correct classification was defined as the sum of true passes and true fails, while incorrect classification was the sum of false pass and false fails.

RESULTS

Performance on the CMTS and predictor tests are provided in Tables 3 and 4, respectively. Three test batteries were developed. The first test battery (Test Battery 1; Table 5), which included all of the predictor tests, resulted in the selection of the medicine ball put, squat lift, beep test, standing long jump, and arm ergometer as significant predictors (Full Model Adjusted R^2=0.85-0.80, $p<0.01$). A second test battery (Test Battery 2; Table 6) excluded any predictive tests which would require calibration (the upright pull, biceps curl, arm ergometer and handgrip tests were excluded). The resulting test battery was identical to the first but without the arm ergometer and resulted in only a small loss of predictive power (Full Model Adjusted R^2=0.81-0.79, $p<0.01$). The final test battery (Test Battery 7; Table 7) consisted of tests that only required a stopwatch and tape measure. This test battery excluded the arm ergometer, handgrip, upright pull, bicep curl, resistance pull, medicine ball put, powerball throw, and squat lift. The resulting test battery consisted of the standing long jump, 1-minute push-ups, 1-minute sit-ups, 300 m sprint, and Illinois agility test (Full Model Adjusted R^2=0.71-0.58, $p<0.01$). Notably, the predictive power of this test battery is below the commonly accepted limit of R^2=0.60 for the 13B MOS (R^2=0.58).

Figure 8 shows the number of Soldiers tested for each of the three sets of MOSs who completed all of their respective CMTS to standard. Overall, 80.5% of the Soldiers tested as 11B, 11C, 12B, 13F, and 19Ds completed their respective CMTS to standard; 72.8% of the Soldiers tested as 13B completed their respective CMTS to standard; and 80.3% of the Soldiers tested as 19K completed their respective CMTS to standard. Estimations of the ability of the test batteries to correctly identify Soldiers who would be qualified to enter the MOSs are provided in Table 8. Correct classification (sum of true

pass and true fails of each battery) ranged from 86.9%-89.9% for Test Battery 1, 85.2%-89.9% for Test Battery 2, and 80.9%-82.3% for Test Battery 3.

DISCUSSION

This study validated the predictive ability four to five physical performance tests to predict performance of the CMTS of all seven Combat Arms MOSs.

TEST BATTERIES

Three test batteries were provided based on three different sets of conditions. Each test battery showed significant predictive power, and each was much better than a test battery based solely on APFT performance (R^2=0.50-0.55, data not shown). While not exactly the same, these test batteries capture similar fitness requirements to those developed by other countries (Table 9). Of particular importance is the inclusion of strength and power measurements, as these are critical to the performance of the critical physically demanding tasks.

Test Battery 1, which included all the covariates, is the best predictor of performance on the criterion tasks based on those predictors tested. This test battery includes the medicine ball put, squat lift, beep test, standing long jump, and arm ergometer. Notably, this test battery consists of tests that capture four different aspects of fitness. The medicine ball put tests upper-body power; the squat lift measures lower-body strength; the beep test captures aerobic capacity; the standing long jump captures lower-body power; and the arm ergometer tests upper-body endurance. While this test battery is optimal from a predictive viewpoint, it does not take into account any limitations in terms of space, budget, or training and maintenance required to use the equipment. Each test has its limitations. For example, the arm ergometer is space efficient and accurate and may be feasible for use in a limited number of test sites. However, purchasing, calibrating and maintaining the arm ergometer for a large number of sites may not be deemed feasible. The medicine ball put is a simple, low cost measurement, but it requires a 3-meter high ceiling and 10 to15 m of open area as a landing site. The squat lift can be performed in a moderately sized footprint with durable weights, but the lifting form must be closely monitored. The beep test is an inexpensive and a well-accepted measure of aerobic capacity, but requires a space about the size of a basketball court and multiple test administrators. The standing long jump is inexpensive, easy to administer and requires little floor space. Details of the time, space, equipment, and cost of each of the predictive tests are provided in Table 10.

Test Battery 2 is the same as the first, except it excludes the arm ergometer. This battery maintains much of the predictive power of the first test battery, without the expense of the arm ergometer.

Test Battery 3 eliminates the need to purchase any equipment other than a stopwatch and a tape measure. The resulting test battery consisted of the standing long jump, 1-minute push-ups, 1-minute sit-ups, 300 meter sprint and Illinois agility test.

All tests except the 300 meter run have a small footprint. The most difficult test to run would be the 300 meter, which would require a track or other large open space. While this test battery is the least expensive, it also has the lowest predictive value of any of the test batteries developed, and therefore the greatest potential to misclassify Soldiers who pass or fail the test. For the 13B, this test results in an R^2 of 0.58 which falls below the generally accepted minimum values for best standards and practices.

ACCURACY OF TEST BATTERIES

To establish an estimate of the accuracy of each proposed test battery, the percentage of Soldiers correctly classified as passing or failing each test battery was calculated. These estimates were based on a multiple hurdle test battery, where Soldiers would have to pass each task. Using our CMTS and standards, 100 (19.5%) of the Soldiers tested were unable to complete all of the tasks of an 11B, 11C, 12B, 13F, or 19D; 49 (27.2%) were unable to complete all of the tasks of a 13B; and 36 (19.7%) were unable to complete all the tasks of a 19K to standard. While more women than men were unable to complete the tasks to standard, the purpose of the test battery is to identify those Soldiers who could be successful should they choose to enter the MOS.

Each test battery has a balance between letting in Soldiers unfit for the MOS and excluding Soldiers who could potentially succeed in the MOS. Estimates of these values for the current cohorts are provided in Table 8. Test Battery 1 correctly identified 55 of the 100 the Soldiers tested as 11B, 11C, 12B, 13F, or 19D who did not complete all CMTS to standard (true fails), but also would exclude 7 individuals who successfully completed all CMTS (false fails). Test Battery 2 identified 56 unsuccessful Soldiers testing in these five MOSs, but would exclude eight who were successful; and Test Battery 3 identified only four unsuccessful Soldiers, while excluding two who were successful. Of the 49 Soldiers who were unsuccessful performing the 13B CMTS, Test Batteries 1-3 would have respectively identified 28, 27, and 26 Soldiers, while excluding 3, 4, and 9 potentially successful Soldiers. For the 19K tasks, of the 36 unsuccessful Soldiers, Test Batteries 1-3 would have respectively identified 20, 21, and five Soldiers, while excluding eight, 12, and two potentially successful Soldiers. Thus, while Test Batteries 1 and 2 may have a greater start-up cost than Test Battery 3, their enhanced ability to identify the right Soldier for the job would likely prevent a greater number injuries to physically unqualified recruits, saving money in the long term.

The physical performance of the average incoming recruit on the predictor tests is likely to be less than that of a trained Soldier. For this reason, it is difficult to establish the exact cut score or to accurately estimate the number of recruits who would qualify for each MOS from the current data. While it would not directly affect the predictive ability of the test battery, if the standards for the CMTS changed considerably from our values, it could affect the percentage of those incorrectly identified as passing or failing.

FOLLOW-UP

Once a predictive test battery is selected, the next step for TRADOC will be the identification of acceptable cutoffs for each predictor test. As there is a degree of error

with any predictive battery, these cutoffs will need to take into account the number of individuals who are both correctly and incorrectly identified as passing or failing the test. By selecting a higher standard to represent in superior performance, this will decrease the number of false positives but also increase the number of false negatives. Along with values for the cut-scores, the type of cut-offs needs to be established. For testing batteries such as the ones presented in this report, there are several potential models to follow for the application of cut scores to make decisions; these include multiple hurdle, compensatory, and hybrid (10).

- In a multiple hurdle test battery, a potential recruit would need to reach a minimum score on each test to pass the test (e.g., scoring at least 60/100 points on each of the four tests).
- With the compensatory test battery, recruits must reach a total score based on the predictors, but they may make up for a poor performance on one predictor with a better performance on another (e.g., requiring a total score of 240 points on four tests scored out of 100 points).
- A hybrid test battery combines these two approaches, where there is a baseline acceptable score on each test, but the total score must be greater than the sum of the acceptable scores (e.g., scoring 50/100 points on all four tests and requiring a total score of 240).

After implementation of this test battery with enforced cut scores, long-term observation of recruits is essential and necessary for the full validation of the test battery. The test should be administered to all Soldiers entering the Combat Arms, and these Soldiers should be tracked throughout their first term of enlistment. The information recorded should include success/failure and time in Initial Military Training, performance on the eight critical tasks, injuries, attrition from the Army, Enlisted Evaluation Reports and reclassification to other MOSs. The entry standards for the test battery must be adjusted based on these data. This will require creation of an on-line database and standardized measurement and recording of these data.

LIMITATIONS

It should be noted that the three test battery options developed are discrete testing batteries. It is not possible to simply swap one test out for another. While any given predictor test represents the core fitness domain (such as lower-body power) that it captures, there is a high correlation among many of the predictor tests, indicating that they have some secondary predictive power in other domains. Thus, replacing one "lower-body power" test with an alternative may not produce an optimal test battery.

The test batteries developed all depend on one key caveat: the correct selection of the criterion tasks. The job performance score being predicted is based on those two to six criterion tasks. While our research indicates that these are the appropriate criterion tasks and standards, and these tasks capture many aspects of the physically demanding tasks of a Combat Arms Soldier, it is possible that there are critical aspects of other tasks not being captured. In the future, it may be necessary to revise the test

battery if new physically demanding tasks are required, or if the task demands change due to changes in equipment.

CONCLUSIONS

The present study proposes three potential OPATs that could be applied for use as a screening tool in order to effectively predict who would be successful in completing the physically demanding tasks of a Combat Arms Soldier.

- Test Battery 1 consists of the medicine ball put, squat lift, beep test, standing long jump, and arm ergometer with R^2=0.80-0.85 predictive power and 87-90% correct classification.
- Test Battery 2 is the same as Test Battery 1 except it excludes the arm ergometer, with R^2=0.79-0.81 predictive power and 85-90% correct identification.
- The final test battery (Test Battery 3) includes the standing long jump, 1-minute push-ups, 1-minute sit-ups, 300 m sprint, and Illinois agility test with R^2=0.58-0.71 predictive power and 81-82% correct identification. The predictive ability of this final Test Battery is below the acceptable industry standards for the 13B.

Use of the first two test batteries could be highly effective in identifying the right Soldier for the right job, ensuring that each Soldier entering IMT has the physical potential to be successful in that MOS.

RECOMMENDATIONS

- The Army should select one of the first two test batteries, based on the equipment they are willing and able to purchase. Consideration should be given to the physical capabilities assessed by the test battery, particularly the inclusion of measures of strength and power.
- Minimal acceptable scores on the criterion tasks need to be established, which can then be used to identify cut scores on the predictor tests.
- Follow-up studies should confirm the validity of this test battery in a separate group of Soldiers including personnel of both sexes.
- The predictive test battery should be run through a series of Soldiers entering one station unit training (OSUT), basic combat training (BCT), or advanced individual training (AIT), and followed through the early years of their career in order to establish the accuracy of the test battery. Follow-ups should be considered on a routine basis to ensure the continued acceptability of the prediction test battery.

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Table 1. List of Physically Demanding Tasks by MOS

		11B	11C	12B	13B	13F	19D	19K
1	Conduct Tactical Movement / Foot March	X	X	X		X	X	X
2	Employ Hand Grenades	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3	Prepare a Fighting Position (Fill and Emplace Sandbags)	X	X	X	X	X	X	X
4a	Drag a Casualty to Immediate Safety	X	X	X	X	X	X	X
4b	Remove a Casualty from a Wheeled Vehicle	X		X		X	X	
5	Maintain 25mm Gun on BFV – Install the Barrel	X		X		X	X	
6	Maintain 25mm Gun on BFV – Remove Feeder Assembly	X		X		X	X	
7	Load 25mm H-EIT Tracer Ammunition Can on BFV	X		X		X	X	
8	Load TOW Missile Launcher on BFV	X					X	
9	Move Over, Through, or Around Obstacles	X	X					
10	Move Under Direct Fire	X	X	[2]		[2]	[2]	[2]
11	Prepare Dismounted TOW Firing Position	X						
12	Engage Targets with a Caliber .50 M2 Machine Gun	X						
13	Lay a 120mm Mortar – Emplace Base Plate		X					
14	Lay a 120mm Mortar – Emplace Cannon		X					
15	Lay a 120mm Mortar for Deflection and Elevation (Traverse)		[1]					
16	Fire a Mortar (Lift and Hold Round, Place in Tube)		X					
17	Mount M2 .50 Cal Machine Gun Receiver on an Abrams Tank							X
18	Stow Ammunition on an Abrams Tank (Load 120mm MPAT Round to the Ready Rack)							X
19	Load the 120mm Main Gun							X
20	Remove a Casualty from an Abrams Tank							X
21	Transfer Ammunition with an M992 Carrier (CAT)				X			
22	Emplace 155mm Howitzer / Lift Wheel Assembly				X			
23	Displace 155mm Howitzer / Recover Spade Trail Arm and Blade				X			
24	Set Up Gun Laying Positioning System (GLPS)				[1]			
25	Establish an Observation Point					[3]		
26	Prepare M1200 Armored Knight Vehicle for Operation					X		
27	Quickly Create a Footpath through Various Obstacles (Carry / Employ Antipersonnel Obstacle Breaching System (APOBS))			X				
28	Prepare Obstacle with the H6 40 lb Cratering Charge			X				
29	Operate a Modular-Pack Mine System (MOPMS)			X				
30	Assist in the Construction of a Bailey Bridge			X				
31	Load / Install a Volcano			X				

X: Task tested

[1] Task not tested due to high skill/technical component of task.

[2] Following Study 1, move under direct fire was determined to be essential to 12B, 13F, 19D and 19K as well.

[3] Task not tested due to similarities with Task 1.

Table 2. Most Physically Demanding Tasks of the Seven Combat Arms MOSs

	11B, 11C, 12B, 13F, 19D	13B	19K
Load Carriage	Foot March		Foot March
Repeated Lift and Carry	Prepare a Fighting Position	Transfer Ammo with a FAASV	Stow Ammo on an Abrams
Heavy Drag	Casualty Drag	Casualty Drag	Casualty Drag
Heavy Lift	Casualty Evacuation	Transfer Ammo with a FAASV	Casualty Evacuation
Controlled Heavy Transfer			Load Main Gun on an Abrams
Agility	Move Under Direct Fire		Move Under Direct Fire

Grayed cells indicate MOS(s) had no task in that physical domain.

Table 3. Criterion Measure Task Simulation (CMTS) Performance

		Foot March Time (min) [a]			Sandbag Carry Time (min) [a]			Move Under Fire Time (min) [a]		
		M	F	C	M	F	C	M	F	C
n		553	230	783	437	187	624	435	188	623
Mean		75.68	89.98	79.88	1.72	2.95	2.09	2.23	2.58	2.34
SD		7.64	12.93	11.52	0.30	1.06	0.85	0.15	0.24	0.24
Minimum		107.83	138.80	138.80	3.43	7.92	7.92	2.91	3.42	3.42
Percentiles	5	90.20	110.78	102.48	2.22	5.23	3.63	2.50	3.00	2.81
	10	86.12	105.23	96.12	2.10	4.43	3.05	2.43	2.88	2.65
	25	79.55	97.77	85.37	1.88	3.23	2.25	2.34	2.73	2.48
	50	74.92	88.60	77.48	1.70	2.67	1.83	2.22	2.57	2.29
	75	70.47	79.92	71.77	1.50	2.25	1.58	2.13	2.42	2.17
	90	66.88	75.31	67.87	1.37	2.02	1.42	2.05	2.30	2.08
	95	65.25	72.20	66.00	1.28	1.90	1.33	2.00	2.21	2.02
Maximum		56.58	66.87	56.58	1.03	1.60	1.03	1.57	1.95	1.57

		Casualty Evacuation Weight (lb)			Casualty Drag Speed (m/s) [a]			FAASV (rounds/min) [a]		
		M	F	C	M	F	C	M	F	C
n		608	230	838	608	230	838	124	73	197
Mean		200	133	182	1.15	0.42	0.95	3.80	1.63	3.00
SD		23	38	41	0.30	0.29	0.44	1.19	0.66	1.47
Minimum		80	50	50	0.12	0.01	0.01	1.07	0.27	0.27
Percentiles	5	140	70	2.50	0.68	0.06	0.15	1.91	0.73	0.93
	10	170	85	2.43	0.79	0.10	0.23	2.26	0.84	1.13
	25	210	110	2.34	0.95	0.18	0.66	2.95	1.13	1.69
	50	210	130	2.22	1.15	0.40	1.02	3.85	1.58	2.82
	75	210	160	2.13	1.33	0.60	1.25	4.36	1.98	4.08
	90	210	190	2.05	1.52	0.81	1.48	5.45	2.39	4.96
	95	210	200	2.00	1.66	0.97	1.59	5.71	2.65	5.64
Maximum		210	210	1.57	2.23	1.55	2.23	7.20	4.53	7.20

		Load Main Gun (s) [a]			Stow Ammo (rounds/min) [a]		
		M	F	C	M	F	C
n		96	93	189	95	92	187
Mean		16.62	24.28	20.39	7.71	3.38	5.58
SD		2.67	5.73	5.87	1.61	1.84	2.77
Minimum		27.36	44.09	44.09	5.33	0.00	0.00
Percentiles	5	21.57	36.88	31.95	5.63	0.20	0.73
	10	20.23	31.95	28.38	5.93	0.73	1.71
	25	17.72	26.38	22.90	6.84	2.02	3.58
	50	16.22	22.80	19.32	7.45	3.58	5.93
	75	15.03	20.62	16.03	8.55	4.53	7.53
	90	13.79	18.87	14.40	9.65	5.68	8.71
	95	12.92	17.21	13.65	10.11	6.24	9.65
Maximum		11.18	13.28	11.18	17.14	8.31	17.14

M: Male; F: Female; C: Combined

[a] Scores were inverted so faster (shorter) times = higher percentile

Table 4. Predictor Test Performance

		Biceps Curl (lb)			Upright Pull (lb)			Squat Lift (lb)		
		M	F	C	M	F	C	M	F	C
n		608	230	838	608	230	838	511	188	699
Mean		101.8	59.6	90.2	323.6	195.8	288.6	215	154	199
SD		19.1	10.4	25.5	54.6	38.2	76.3	15	37	36
Minimum		51.3	28.2	28.2	159.7	114.6	114.6	60	80	60
Percentiles	5	73.9	42.0	50.9	235.0	139.8	159.0	180	100	120
	10	79.4	47.3	55.9	251.2	149.2	181.3	200	100	140
	25	88.6	52.8	68.9	288.9	169.4	228.0	220	120	180
	50	100.0	59.7	91.8	319.6	193.4	298.5	220	140	220
	75	112.6	66.8	107.8	358.7	221.0	345.8	220	180	220
	90	127.1	73.0	122.8	394.7	239.8	384.1	220	220	220
	95	134.4	78.0	131.0	414.7	255.6	407.0	220	220	220
Maximum		203.7	91.8	203.7	489.2	403.1	489.2	220	220	220

		Handgrip (lb)			Medicine Ball Put (cm)			Standing Long Jump (cm)		
		M	F	C	M	F	C	M	F	C
n		606	230	836	608	229	837	608	230	838
Mean		203.36	131.42	183.57	635.2	424.9	577.7	207.3	160.8	194.5
SD		39.00	25.23	48.07	83.8	54.8	121.3	25.5	20.1	31.9
Minimum		89.35	75.45	75.45	451.5	300.5	300.5	114.5	101.5	101.5
Percentiles	5	141.30	92.50	106.95	507.5	342.0	373.5	167.5	129.0	141.0
	10	153.70	99.43	120.90	527.6	356.2	403.0	176.0	134.5	152.0
	25	175.95	114.70	146.78	575.5	386.5	488.2	188.5	146.5	172.5
	50	203.50	131.00	184.13	631.0	422.0	593.5	206.8	160.0	195.0
	75	229.25	148.70	217.63	685.5	455.0	666.0	223.0	175.5	216.5
	90	249.90	162.90	243.95	744.0	500.5	726.5	241.5	187.5	235.5
	95	265.35	174.90	258.70	783.5	526.5	777.5	252.5	193.0	248.0
Maximum		388.35	208.15	388.35	927.0	577.0	927.0	284.0	204.0	284.0

		Resistance Pull (m/s)			300m Sprint (min) [a]			Powerball Throw (cm)		
		M	F	C	M	F	C	M	F	C
n		436	139	575	607	229	836	512	188	700
Mean		0.84	0.22	0.69	0.88	1.06	0.93	600.8	333.3	529.0
SD		0.35	0.18	0.41	0.09	0.11	0.13	118.6	84.8	162.1
Minimum		0.01	0.00	0.00	1.25	1.53	1.53	258.0	166.5	166.5
Percentiles	5	0.33	0.02	0.07	1.03	1.25	1.15	407.5	214.5	262.8
	10	0.48	0.05	0.14	1.00	1.20	1.10	453.0	239.0	294.0
	25	0.66	0.10	0.37	0.94	1.12	1.01	518.0	272.5	397.0
	50	0.83	0.16	0.73	0.87	1.06	0.91	597.5	325.8	547.5
	75	1.01	0.31	0.94	0.82	1.00	0.84	666.5	380.8	641.8
	90	1.17	0.50	1.14	0.77	0.93	0.78	766.5	438.0	733.8
	95	1.30	0.60	1.26	0.75	0.90	0.76	806.0	478.0	790.3
Maximum		3.81	0.83	3.81	0.68	0.83	0.68	999.0	665.0	999.0

M: Male; F: Female; C: Combined

[a] Scores were inverted so faster (shorter) times = higher percentile

Table 4. (continued)

		Arm Ergometer (#)			1-Minute Push-up (#)			1-Minute Sit-up (#)		
		M	F	C	M	F	C	M	F	C
n		608	230	838	608	230	838	607	230	837
Mean		261	195	243	50	31	45	46	45	46
SD		32	35	44	11	8	13	6	6	6
Minimum		139	74	74	21	14	14	18	31	18
Percentiles	**5**	207	144	161	34	18	23	37	35	36
	10	222	153	180	37	20	27	39	37	38
	25	240	172	215	43	25	36	42	40	42
	50	263	193	250	49	31	45	46	45	46
	75	283	215	275	56	37	53	50	49	50
	90	300	241	296	64	42	62	55	53	54
	95	311	260	306	69	47	67	56	55	56
Maximum		357	290	357	94	53	94	66	62	66

		Beep Test Shuttles (#)			Step Test Duration (min) [a]			Illinois Agility Test (min) [a]		
		M	F	C	M	F	C	M	F	C
n		607	228	835	94	44	138	608	229	837
Mean		64	44	59	3.41	1.92	2.94	0.32	0.35	0.33
SD		17	12	18	1.32	0.97	1.40	0.03	0.03	0.03
Minimum		20	17	17	0.92	0.82	0.82	0.50	0.56	0.56
Percentiles	**5**	40	25	32	1.48	1.00	1.08	0.37	0.40	0.38
	10	43	30	37	1.68	1.07	1.22	0.35	0.39	0.37
	25	52	36	45	2.27	1.20	1.75	0.33	0.37	0.34
	50	63	42	56	3.35	1.65	2.52	0.32	0.35	0.32
	75	75	52	71	5.00	2.23	4.28	0.30	0.33	0.30
	90	89	60	83	5.00	3.15	5.00	0.29	0.32	0.29
	95	95	67	93	5.00	4.30	5.00	0.28	0.31	0.28
Maximum		147	92	147	5.00	5.00	5.00	0.26	0.29	0.26

M: Male; F: Female; C: Combined

[a] Scores were inverted so faster (shorter) times = higher percentile

Table 5. Regression Coefficients of Test Battery 1

		Constant	Medicine Ball Put (cm)	Squat Lift (lb)	Beep Test (shuttles)	SLJ[1] (cm)	AE[2] (#)	R^2
Full Model Z-Score	**11B, 11C, 12B, 13F, 19D**	*-22.568**	0.011*	0.034*	0.029*	0.023*	0.014*	*0.80*
	13B	*-8.873**	0.006*	0.010*	0.004	0.008*	0.008*	*0.82*
	19K	*-27.343**	0.012*	0.026*	0.042*	0.023*	0.037*	*0.85*
Individual CMTS Raw Score	**Foot March** (min)	*118.010**	-0.031*	-0.052*	-0.150*	0.020	-0.021	*0.42*
	Sandbag Carry (min)	*6.478**	-0.001*	-0.008*	-0.003	-0.005*	-0.005*	*0.59*
	Move Under Fire (min)	*3.417**	0.0004*	0.000	0.003*	0.002*	-0.001*	*0.56*
	Casualty Evacuation (lb)	*-19.782**	0.023	0.582*	0.014	0.150*	0.180*	*0.64*
	Cas. Drag (m/s)	*-1.286**	0.001*	0.003*	-0.001*	0.002*	0.001*	*0.70*
	FAASV (rounds/min)	*-3.390**	0.004*	0.004	0.013*	0.005	0.009*	*0.65*
	Load the Main Gun (s)	*45.807**	-0.008*	-0.036*	-0.013	-0.011	-0.048*	*0.61*
	Stow Ammo (rounds/min)	*-7.928**	0.005*	0.012*	0.014*	0.010*	0.023*	*0.79*

[1] Standing Long Jump
[2] 2-Minute Arm Ergometer
*p≤0.05

Table 6. Regression Coefficients of Test Battery 2

		Constant	Medicine Ball Put (cm)	Squat Lift (lb)	Beep Test (shuttles)	SLJ[1] (cm)	R^2
Full Model Z-Score	**11B, 11C, 12B, 13F, 19D**	*-21.721**	0.013*	0.039*	0.037*	0.022*	*0.79*
	13B	*-8.457**	0.007*	0.013*	0.009	0.007*	*0.81*
	19K	*-24.428**	0.017*	0.040*	0.068*	0.020*	*0.80*
Individual CMTS Raw Score	**Foot March** (min)	*116.599**	-0.034*	-0.061*	-0.165*	0.022	*0.42*
	Sandbag Carry (min)	*6.200**	-0.002*	-0.010*	-0.006*	-0.004*	*0.57*
	Move Under Fire (min)	*3.379**	0.0005*	-0.001*	-0.003*	-0.002*	*0.55*
	Casualty Evacuation (lb)	*-7.631*	0.045*	0.659*	0.136*	0.133*	*0.62*
	Casualty Drag (m/s)	*-1.187**	0.002*	0.004*	0.000	0.002*	*0.69*
	FAASV (rounds/min)	*-2.865**	0.005*	0.006*	0.019*	0.003	*0.63*
	Load the Main Gun (s)	*42.068**	-0.014*	-0.054*	-0.046*	-0.007	*0.54*
	Stow Ammo (rounds/min)	*6.121**	0.008*	0.021*	0.030*	0.008	*0.72*

[1] Standing Long Jump
*p≤0.05

Table 7. Regression Coefficients of Test Battery 3

		Constant	SLJ[1] (cm)	1-Minute Push-ups (#)	1-Minute Sit-ups (#)	300m Sprint (min)	Illinois Agility (min)	R^2
Full Model Z-Score	**11B, 11C, 12B, 13F, 19D**	*2.020*	0.043*	0.108*	-0.097*	-5.955*	-14.961*	*0.63*
	13B	*-2.729*	0.024*	0.043*	-0.026	-2.680*	-0.350	*0.58*
	19K	*13.529**	0.032*	0.107*	-0.040	-10.881*	-36.755*	*0.71*
Individual CMTS Raw Score	**Foot March** (min)	*66.743**	-0.027	-0.236*	0.074	29.978*	-7.608	*0.32*
	Sandbag Carry (min)	*0.938*	-0.007*	-0.016*	0.022*	1.373*	2.940*	*0.45*
	Move Under Fire (min)	*2.232**	-0.002*	-0.005*	-0.001	0.251*	1.528*	*0.57*
	Casualty Evacuation (lb)	*215.490**	3.230*	0.873*	-0.871*	-67.265*	-99.317*	*0.43*
	Casualty Drag (m/s)	*0.519*	0.006*	0.007*	-0.010*	-0.547*	-0.325*	*0.47*
	FAASV (rounds/min)	*1.753*	0.016*	0.031*	-0.015	-2.010	-1.240	*0.46*
	Load the Main Gun (s)	*-6.965*	-0.004	-0.071	0.046	15.052*	44.809*	*0.48*
	Stow Ammo (rounds/min)	*10.533**	0.019*	0.055*	-0.045*	-5.986*	-9.091	*0.62*

[1] Standing Long Jump
*p≤0.05

Table 8. Accuracy of Test Batteries

		Test Battery 1: Medicine Ball Put + Squat Lift + Beep Test + Standing Long Jump + 2-min Arm Ergometer		**Test Battery 2:** Medicine Ball Put + Squat Lift + Beep Test + Standing Long Jump		**Test Battery 3** Standing Long Jump + 1-Minute Push-Ups + 1-Minute Sit-Ups + 300 m Sprint + Illinois Agility Test	
MOS(s)	**Classification**	**n**	**%**	**n**	**%**	**n**	**%**
11B, 11C, 12B, 13F, 19D (n=514)	True Pass[a]	407	79.2%	406	79.0%	411	80.0%
	True Fail[b]	55	10.7%	56	10.9%	4	0.8%
	False Pass[c]	45	8.8%	44	8.6%	96	18.7%
	False Fail[d]	7	1.4%	8	1.6%	2	0.4%
	Correctly Classified[e]	*462*	*89.9%*	*462*	*89.9%*	*415*	*80.9%*
13B (n=180)	True Pass[a]	128	71.1%	127	70.6%	122	67.8%
	True Fail[b]	28	15.6%	27	15.0%	26	14.4%
	False Pass[c]	21	11.7%	22	12.2%	23	12.8%
	False Fail[d]	3	1.7%	4	2.2%	9	5.0%
	Correctly Classified[e]	*156*	*86.7%*	*154*	*85.6%*	*148*	*82.3%*
19K (n=183)	True Pass[a]	139	76.0%	135	73.8%	145	79.2%
	True Fail[b]	20	10.9%	21	11.5%	5	2.7%
	False Pass[c]	16	8.7%	15	8.2%	31	16.9%
	False Fail[d]	8	4.4%	12	6.6%	2	1.1%
	Correctly Classified[e]	*24*	*86.9%*	*156*	*85.2%*	*150*	*82.0%*

Classifications:
[a] **True Pass**: Successfully completed all criterion tasks to standard; correctly identified by predictive model
[b] **True Fail**: Did not complete one or more criterion tasks to standard; correctly identified by predictive model
[c] **False Pass**: Did not complete one or more criterion tasks to standard; incorrectly identified by predictive model
[d] **False Fail**: Successfully completed all criterion tasks to standard; incorrectly identified by predictive model
[e] ***Correctly Classified***: Sum of True Pass and True Fail

Standards:
Foot March (11B, 11C, 12B, 13F, 19D, 19K): 1 h 47 min (based on a 4 mph standard, less a 20% train-up)
Sandbag Carry (11B, 11C, 12B, 13F, 19D): 16 min (based on 26 min to move 26 sandbags standard)
Move Under Fire (11B, 11C, 12B, 13F, 19D, 19K): as fast as possible (all Soldiers who complete the task are considered passing)
Casualty Evac. (11B, 11C, 12B, 13F, 19D, 19K): 103.5 lb (based on 1/2 of 2-person 207-lb lift standard)
Casualty Drag (11B, 11C, 12B, 13B, 13F, 19D, 19K): 0.25 m/s, or 15 m in 60 s
FAASV (13F): 2 rounds/min or (30 rounds in 15 min)
Main Gun (19K): 5 rounds in 35 s
Stow Ammo (19K): 1.8 round/min or 18 rounds in 10 min (based on 36 rounds in 20 min standard)

Note: The Estimated % Misclassified are based only on the individuals studied and may not be representative of the full Army.
**% of Soldiers studied who would have been misclassified, based on the standards listed in the methods.*

Table 9. Physical Domains of Current and Proposed Military Employment Testing Batteries

		Strength	Power	Muscular Endurance	Aerobic Capacity	Agility
Existing Test Batteries	**Australia** (2)	Box Lift and Place		Jerry Can Carry Weight Load Carry	Weight Load Carry	Fire and Movement
	Canada (4, 5)		Sandbag Drag	Sandbag Lift Intermittent Loaded Sandbags	Sandbag Lift Intermittent Loaded Sandbags	20m Rushes
	United Kingdom (3, 22, 23)	Static Lift		Jerry Can Carry 2-Minute Push-Ups 2-Minute Sit-Ups	1.5 Mile Run	
Proposed OPATs	**Test Battery 1**	Squat Lift	Medicine Ball Put Standing Long Jump	Arm Ergometer	Beep Test	
	Test Battery 2	Squat Lift	Medicine Ball Put Standing Long Jump		Beep Test	
	Test Battery 3		300m Sprint	1-Minute Sit-ups 1-Minute Push-Ups		Illinois Agility Test

Table 10. Summary of Requirements for Predictive Tests

Test *Physical Domain*	Key Equipment	Approximate Space[1] (can overlap)	Approximate Cost	Approximate Time per Person[2]
Medicine Ball Put *Upper-Body Power*	• 2-kg Medicine Ball • Tape Measure	30' x 6'	$25	1 Minute
Squat Lift *Lower-Body Strength*	• Sets of dumbbells from 50-210 lb *(Not all weights necessarily needed)*	~3' x 3' / weight	(~$1/lb)[3]	~ 1 Minute / Weight *(can run multiple recruits at once)*
Beep Test *Aerobic Capacity*	• Audio Playback Device (CD/MP3 Player) • Tape Measure • Stopwatch	66' (20m) x 10' / simultaneous person	Negligible	Up to 15 Minutes *(can run multiple recruits at once)*
Standing Long Jump *Lower-Body Power*	• Pre-marked Floor Mat *(or Tape Measure)*	15' x 3'	~$300 *(Negligible w/o mat)*	1 Minute *(can run multiple recruits at once)*
Arm Ergometer *Upper-Body Endurance*	• Arm Ergometer • Stopwatch	3' x 3' table space	~$2500	4-5 Minutes
1-Minute Push-ups *Upper-Body Endurance*	• Stopwatch	7' x 3' / simultaneous person	Negligible	2 Minutes *(can run multiple recruits at once)*
1-Minute Sit-ups *Core Endurance*	• Stopwatch	7' x 3' / simultaneous person	Negligible	2 Minutes *(can run multiple recruits at once)*
300m Sprint *Lower-Body Power*	• Tape Measure • Stopwatch	300+ m (~1000') *or multiple laps of a smaller space*	Negligible	2 Minutes
Illinois Agility *Agility*	• Cones • Tape Measure • Stopwatch	~ 50' x 30'	Negligible	1 Minute

[1] All space should be on non-slippery surfaces, reasonably flat, and clear of obstacles.
[2] Time per person includes time to provide instructions. Time may be faster if multiple Soldiers are tested simultaneously.
[3] Dumbbells cost ~$1/lb. Total Cost depends on the number and size of dumbbells used for testing.

Figure 1. Diagram and Photos of the Move Under Fire Simulation

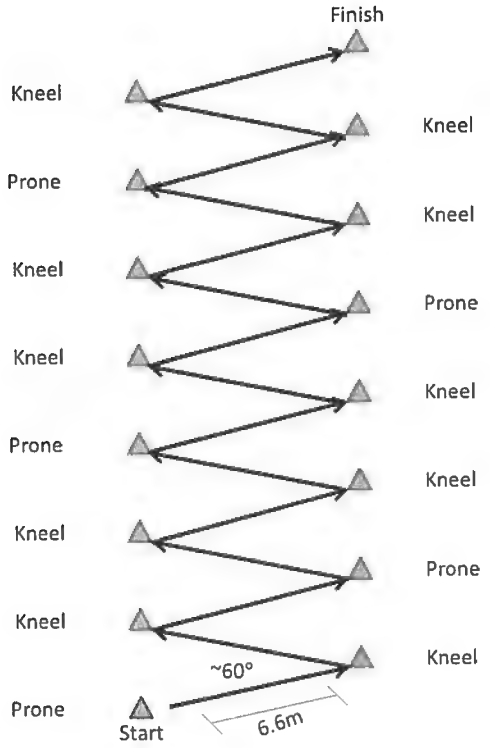
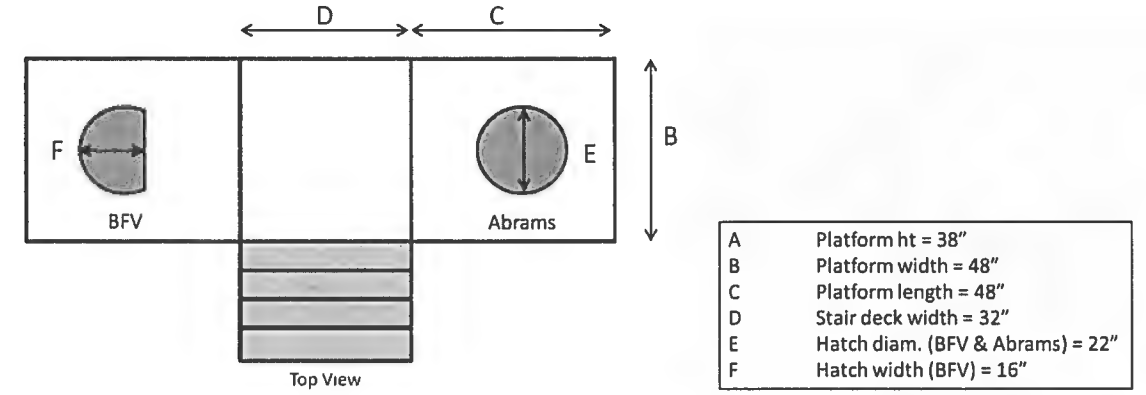


Figure 2. Diagrams and Photos of the Casualty Evacuation Simulation



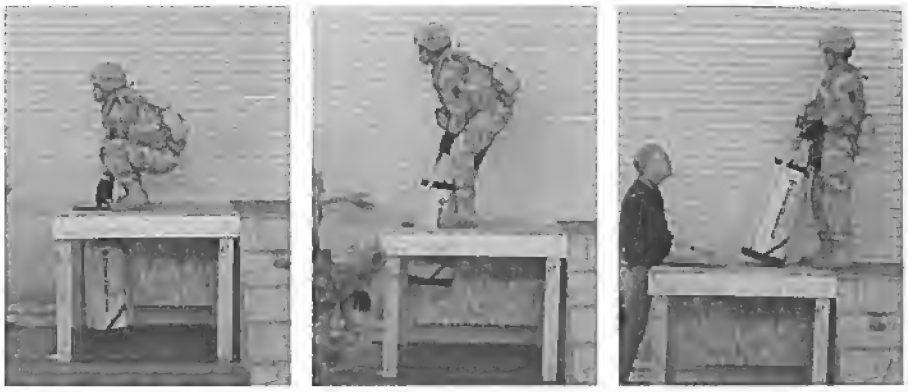
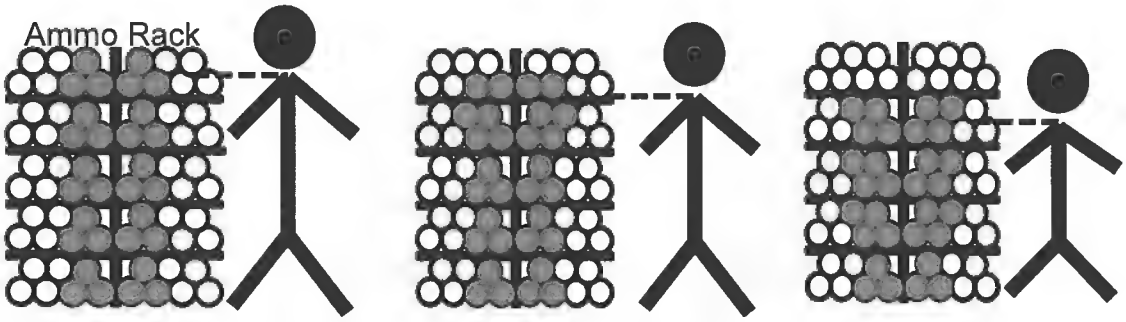


Figure 3. Photo of the Casualty Drag Simulation

Figure 4. Diagrams and Photos of the Reload Ammo with a FAASV Simulation



Ammo rack loaded to shoulder height. Filled circles represent spaces a Soldier of a given height would be expected to load.

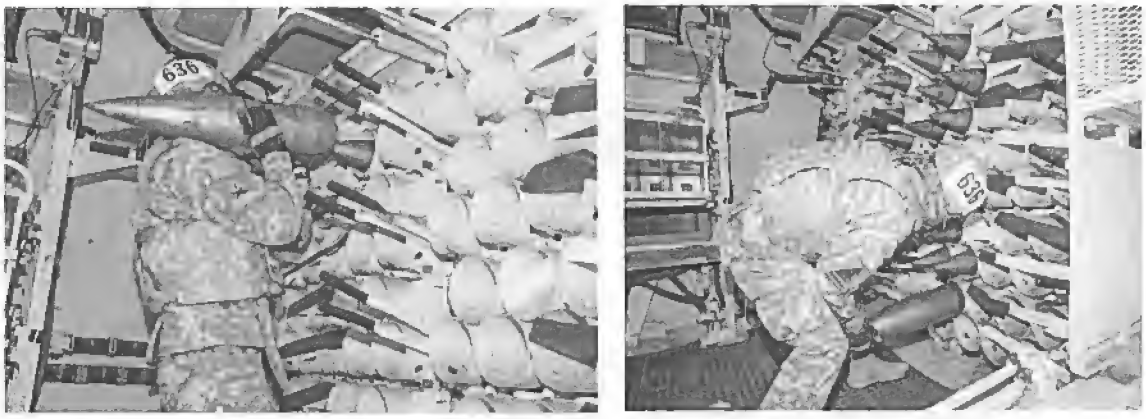
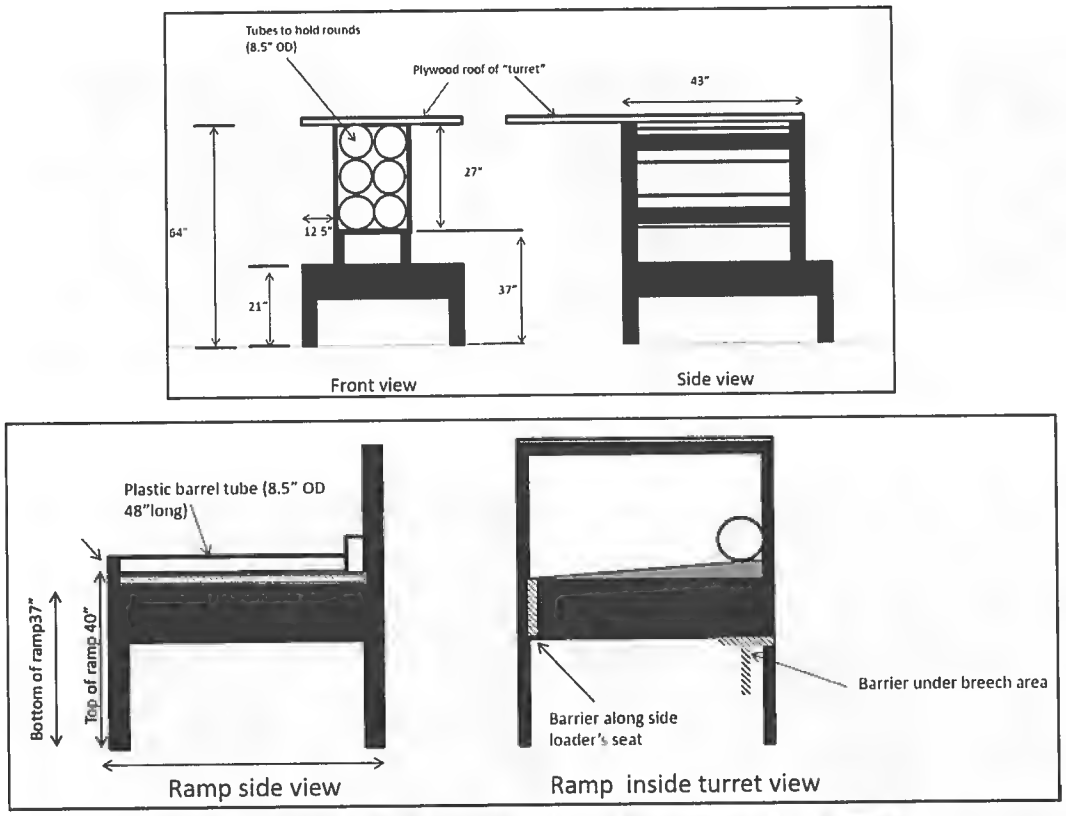


Figure 5. Diagrams and Photo of the Load Main Gun Simulation



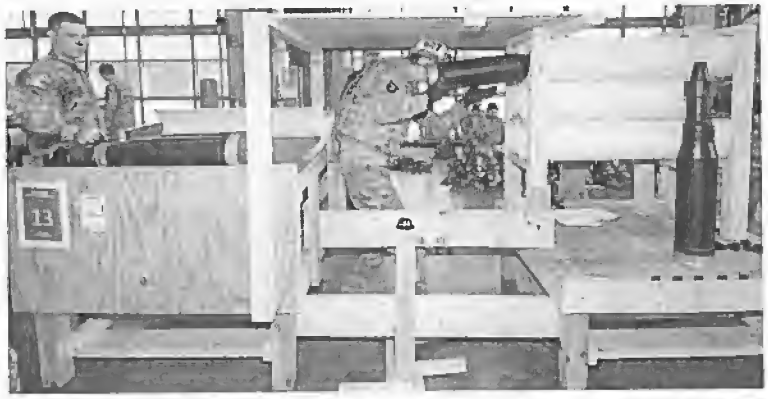


Figure 6. Diagrams and Photos of the Stow Ammo Simulation

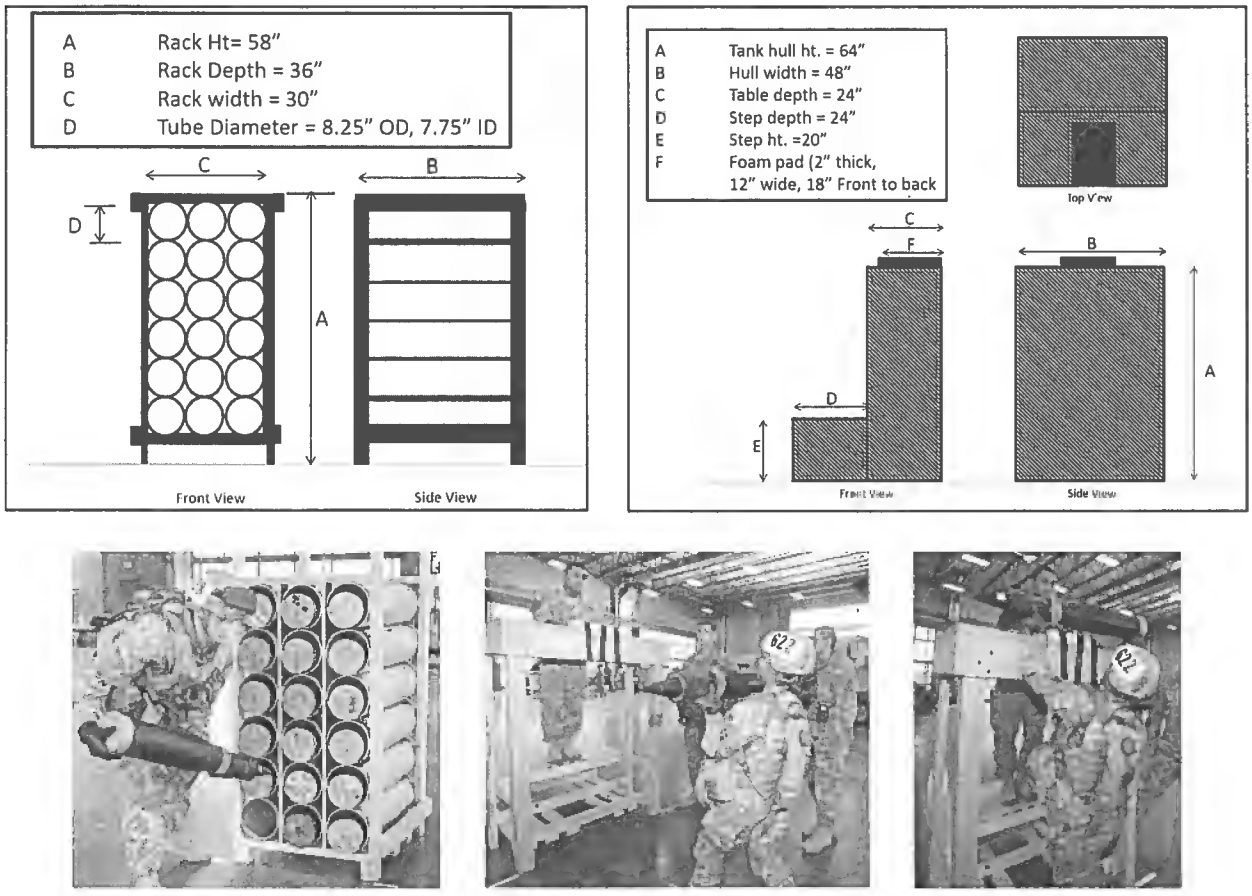


Figure 7. Schematic of the Illinois Agility Test

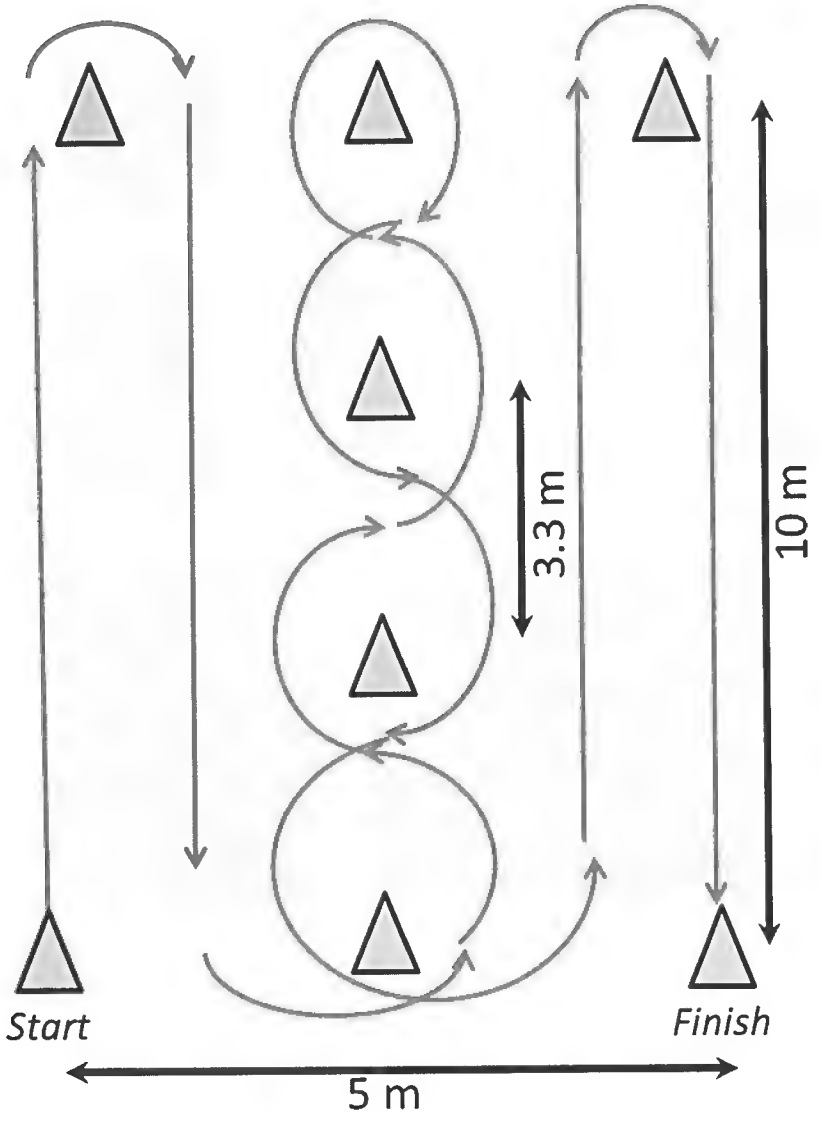
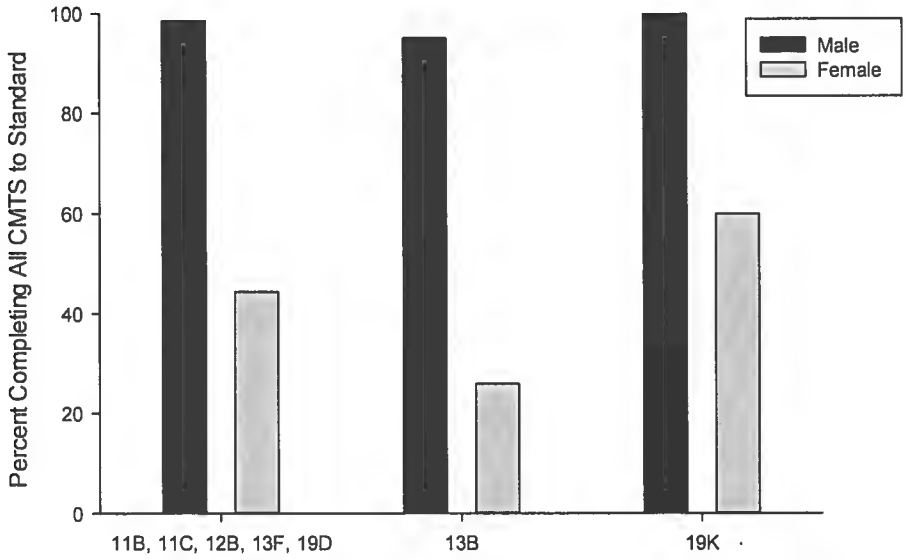


Figure 8. Percent of Tested Soldiers Completing all CMTS to Standard



Standards:
Foot March (11B, 11C, 12B, 13F, 19D, 19K): 1 h 47 min (based on a 4 mph standard, less a 20% train-up)
Sandbag Carry (11B, 11C, 12B, 13F, 19D): 16 min (based on 26 min to move 26 sandbags standard)
Move Under Fire (11B, 11C, 12B, 13F, 19D, 19K): as fast as possible (all Soldiers who complete the task are considered passing)
Casualty Evac. (11B, 11C, 12B, 13F, 19D, 19K): 103.5 lb. (based on 1/2 of 2-person 207-lb lift standard)
Casualty Drag (11B, 11C, 12B, 13B, 13F, 19D, 19K): 0.25 m/s, or 15 m in 60 s
FAASV (13F): 2 rounds/min or (30 rounds in 15 min)
Main Gun (19K): 5 rounds in 35 s
Stow Ammo (19K): 1.8 round/min or 18 rounds in 10 min (based on 36 rounds in 20 min standard)

APPENDIX A. PHYSICAL PRE-EMPLOYMENT TEST BATTERIES DEVELOPED BY THE ARMED FORCES OF AUSTRALIA, CANADA, AND THE UNITED KINGDOM

Country	Soldiering task tests	Field-expedient tests
Australia (2)	All Corps • Load Carriage • Combat Rushes • Jerry Can Carry • Heavy Equipment Lift Artillery • All Corps + moving ammunition for a M777A2 conducting a 10-round fire for effect Infantry • All Corps + Casualty Drag	All Corps • Weight Load March • Fire and Movement • Jerry Can Carry • Box Lift and Place Artillery • All Corps + Repeatedly Lift and Carry 10 m an Inert Artillery Round Infantry • All Corps + Simulated Casualty Drag
Canada (4, 5, 25)	• Escape to Cover • Sandbag Fortification • Pickets and Wire Carry • Picking and Digging • Vehicle Extrication • Stretcher Carry	• Sandbag Lift • Intermittent Loaded Shuttles • 20-Meter Rushes • Sandbag Drag
United Kingdom (3, 22, 23)	• Jerry Can Carry • Load Carriage • Single Ammo Box Lift	• 1.5 Mile Run/Beep Test • Jerry Can Carry • Static Lift • Sit-Up • Push-Up

APPENDIX B. RELATIVE AND ABSOLUTE RELIABILITY OF CMTS

Test	n	Trial Comparison	Relative	Absolute		
			ICC (2,1) [95%CI]	SEM (% of Mean)	95% LOA	95% Ratio LOA
Foot March (min)	48	1 vs 2	0.76 [0.61-0.86]	5.89 (7%)	16.34	
Sandbag Carry (min)	50	1 vs 2	0.87 [0.78-0.92]	0.27 (12%)	0.75	
	50	2 vs 3	0.85 [0.75-0.91]	0.25 (12%)		33%
Move Under Fire (min)	49	1 vs 2	0.90 [0.82-0.94]	0.08 (3%)	0.21	
	46	2 vs 3	0.93 [0.88-0.96]	0.06 (3%)	0.16	
Casualty Evacuation (lb)	49	1 vs 2	0.94 [0.90-0.97]	15.25 (10%)	32.9	
	49	2 vs 3	0.96 [0.94-0.98]	9.26 (6%)	25.7	
Casualty Drag (m/s)	50	1 vs 2	0.90 [0.83-0.94]	0.13 (11%)	0.35	
FAASV (Rounds/min, 15 min max)	46	1 vs 2	0.93 [0.88-0.96]	0.40 (15%)		40%
	44	2 vs 3	0.93 [0.88-0.96]	0.44 (14%)	1.22	
	42	3 vs 4	0.93 [0.88-0.96]	0.45 (13%)	1.25	
Load Main Gun (s)	49	1 vs 2	0.84 [0.73-0.90]	2.82 (12%)		33%
	46	2 vs 3	0.90 [0.83-0.94]	1.92 (10%)		27%
	44	3 vs 4	0.93 [0.88-0.96]	1.36 (7%)		21%
Stow Ammo (rounds/min)	49	1 vs 2	0.94 [0.89-0.96]	0.72 (18%)	1.97	
	46	2 vs 3	0.93 [0.88-0.96]	0.75 (16%)	2.07	

Shaded cells indicate a significant learning effect between trials ($p<0.05$)

APPENDIX C. INSTRUCTIONS FOR CMTS AND PREDICTOR TESTS

Conduct a Tactical Movement

The purpose of the test is to determine the ability for simple tests to predict performance on a 4-mile road march. You will walk 4 miles as fast as possible without running or doing the airborne shuffle. Your weapon should be held at the ready in front of you at all times. To start you will insert your SPORTident stick into the clear and test receptacles. You will report your heart rate, then insert your Sportident into the start receptacle. As soon as it beeps, your time is running. Walk on the right side of the road out and back. At each 0.5 mile and mile mark, there will be a set of cones. Walk in-between the two cones on the right side of the road. You should hear a beep from your stick as you pass, but you don't need to do anything. Do NOT stop to rest at the cones because your stick will keep recording times. Move at least 25 feet away before you stop. As you walk through the cones marked mile 4, check your heart rate and remember the number.

When you get to the finish cones, punch out with your SPORTident stick. Upon completion of the task, you will report your heart rate. You will also rate your physical effort on a scale from 6 to 20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task.

Next we will ask you to point out the pain, soreness and discomfort you experienced during the march. Identify all regions in which you are currently feeling any discomfort and then rate that discomfort from 0 (No Discomfort) to 3 (Extreme Discomfort). If you are not experiencing any discomfort, you may skip that region.

To complete participation you will return the SPORTident stick, return your weapon to the supply closet, return your weights, and return your heart watch and strap to station 1. Do you have any questions?

Prepare a Fighting Position (Sandbag Carry and Emplace)

The purpose of this task is to determine the relationship between performance of carrying and emplacing 16 filled sandbags and simple predictor tests. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When I say go, you will carry a total of 16 sandbags 10 meters where you will build a fighting position that is four sandbags wide, two sandbags deep, and two sandbags tall (Figure A). You may carry no more than two sandbags at a time, and you must properly place the sandbags you are carrying within the marked outline before returning for the next bag.

Upon completion of the task, you will be asked for your heart rate. You will also rate your physical effort on a scale from 6 to 20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

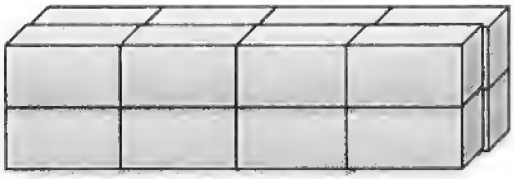
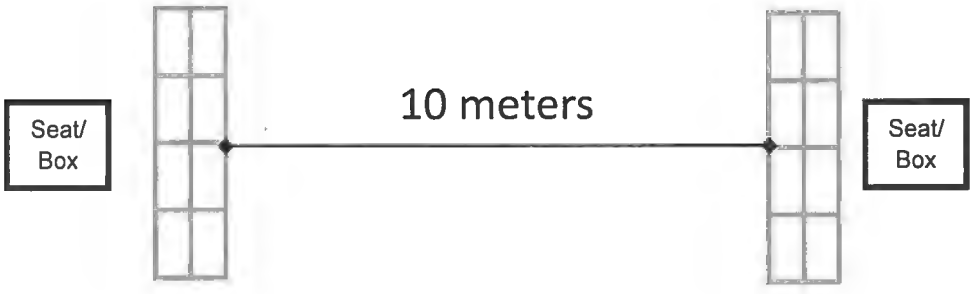


Figure A. Design of fighting position.



Move Under Direct Fire

The purpose of this task is to determine the relationship between performance of a test designed to simulate moving 100 meters under direct fire and simple predictor tests. Make sure the chest strap of your heart rate monitor is tight and your heart rate is displayed on the watch (check now). You will begin the test lying in an unsupported prone fighting position.

When told to begin, you will rise and sprint to the first marker. Get right next to the marker and assume a kneeling fighting position. After 5 seconds, we will cue you to run to the next marker. You will sprint, get right next to the 2nd marker, and again assume a kneeling fighting position. You will continue sprinting between markers in a similar manner, cycling between one prone, and two kneeling positions, until you have completed the entire course. The signs next to each cone will instruct you whether to kneel or get prone. When getting up, you may not use the barrel of the gun for support. On the final sprint, run straight through the finish line.

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. Once you start the test, do not stop unless it is an emergency. You should continue even if you stumble, as you may not be allowed to restart. Upon completion of the task, you will be asked for your heart rate. You will also be asked to rate your physical effort on a scale from 6 to 20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

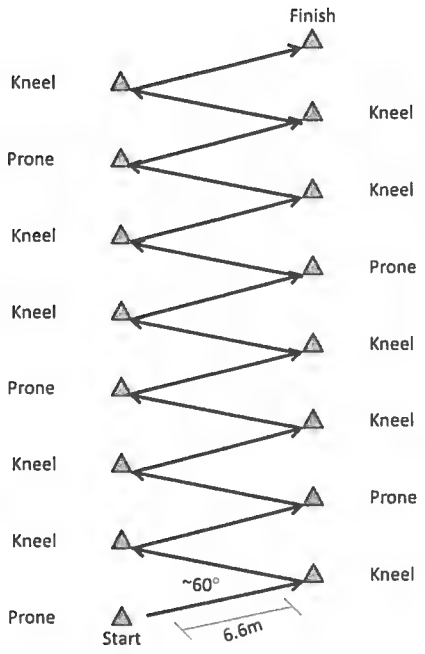


Figure A. Course Diagram Option 1

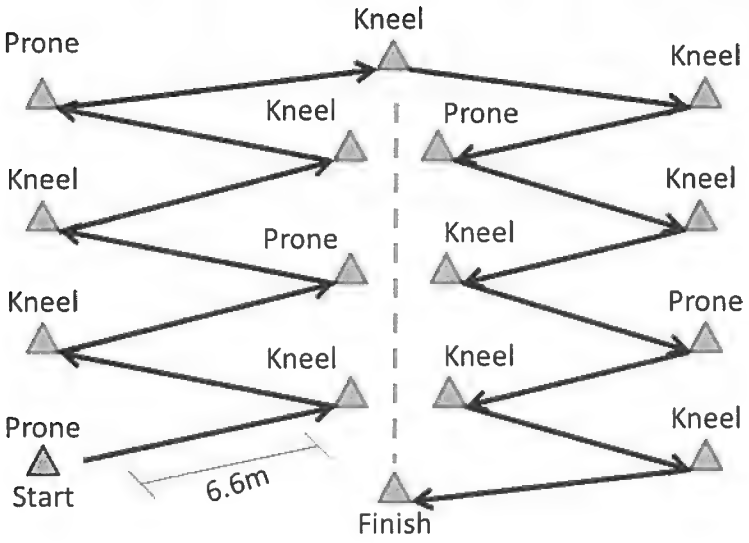


Figure B. Course Diagram Option 2

Casualty Evacuation

The purpose of this task is to determine the relationship between performance of a maximal heavy lift test designed to mimic removing a casualty from a vehicle turret, and simple predictive tests. You will squat, grasp the shoulder straps and pull the bag out through the hole simulating the commander's hatch. You must lift the bag up and place it beside the hatch (either upright or on its side) for it to be considered successful.

Make sure you are wearing gloves. Prior to starting we will review proper lifting technique using a set of 25-lb kettlebells. You will be required to use good technique on every lift to protect your lower back. If you show poor lifting technique, we will stop you and you will not receive credit for that weight. If you feel any pain or discomfort, you should release the weight and stop performing the task.

After everyone has completed the 50 lb, we will cycle through everyone again. You may choose add 10-, 20-, or 30 lb to the bag after each successful lift. However, the tester may ask you to perform a lower weight if it is deemed appropriate. The maximum lift for this test is 210 lb. You may be skipped during some cycles in order to minimize the time we spend adjusting the bag.

Upon completion of each lift, you will rate your physical effort on a scale from 0 to 10. This rating should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people (show scale). Look at this rating scale: 0 means "no exertion at all," and 10 means "Extremely Hard."

Your rating should reflect only your effort for that particular weight, and not be solely based on whether or not you lifted the bag. Do you have any questions?

Casualty Drag

The purpose of this task is to determine the relationship between performance of dragging a 270 lb. casualty a distance of 15 meters and simple predictor tests. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When told to begin, you will grasp the harness on the dummy with one or two hands and drag it as quickly as possible past the 2nd set of cones. The feet of the dummy must cross the line before you stop, so don't stop until I tell you to. You will have 60 seconds to complete this task and I will count down the last 5 seconds and say 'stop'. If you cross the finish line within 60s, I'll tell you when to stop (Figure A). If you do not cross the finish line when I count down and say 'stop', stop right where you are and wait until I tell you to release the dummy (Figure B). I will measure how far you dragged it.

Upon completion of the task, you will rate your physical effort on a scale from 0 to 10. This rating should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people (show scale). Look at this rating scale: 0 means "no exertion at all," and 10 means "Extremely Hard."

You should perform the task as quickly as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Before we start the test, you will drag the dummy a few feet to get a feel for the weight. Do you have any questions?

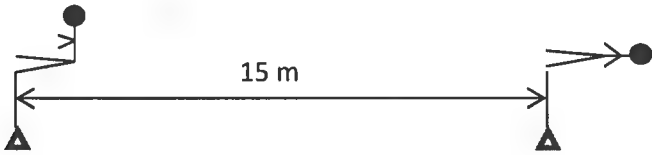


Figure A. If completed task (Record 15 meters and actual completion time)

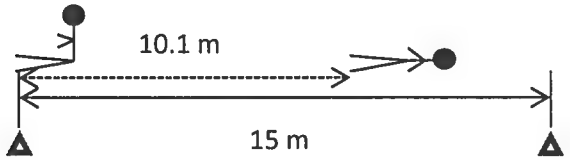


Figure B. If task not completed (Record 30 seconds and distance to feet)

Transfer Ammunition with an M992 Field Artillery Ammunition Support Vehicle (Reload Ammo with a FAASV)

The purpose of this test is to determine the relationship between loading 30 rounds into the FAASV and simple predictor tests. Before beginning, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch (check now). Also, make sure your gloves are on.

This task requires you to lift the rounds from the back of the FAASV and place them in the ammunition rack in the specified slots. Prior to testing, we will check your height in the FAASV, since you will only be required to fill up to shoulder height. You must carry the rounds; you may not roll them. You will have up to 20 minutes to move up to 30 rounds. The time will be split into three work shifts of 5 minutes, with a mandatory 2.5 minutes rest in between each shift. I will provide warnings when time is running out in each shift. When I alert you that each shift is up, you must safely place the shell down at your current position. When the rest is over, you will resume from the position you left off.

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. You can stop and rest as necessary. If you are unable to continue even after a break, tell the administrator, and we will terminate the test.

Upon completion of the task, you will be asked for your heart rate. You will also rate your physical effort on a scale from 6 to 20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.

13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.

17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.

19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

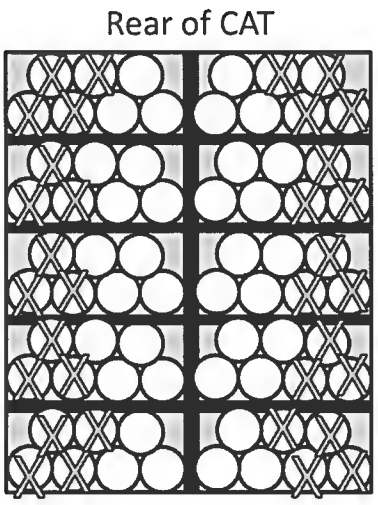


Figure A. Design of FAASV layout

Load the 120mm Main Gun

The purpose of this task is to determine the relationship between performance of a test simulating moving 5 MPAT Rounds from the Ready Rack into the Breach of an Abrams tank and simple predictor tests. Before we begin, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch (check now). Also, make sure your gloves are on.

Inside the Abrams tank simulation, you will move five 120 millimeter MPAT rounds. You will grab a round from the bustle rack, do a proper flip or turn, and then push the round into the simulated breach. After each round you will hit the button simulating the firing of the gun. You will then grab the next round and repeat this process until you have loaded all five rounds. Prior to starting, you will be given an opportunity to practice the proper technique. Once you have mastered the technique, we will begin the testing. Each person will complete the testing three times. You will rotate through in round robin order.

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. If at any point you feel you are unable to continue, the test will be terminated.

Upon completion of the task, you will be asked for your heart rate. You will also be asked to rate your physical effort on a scale from 6 to 20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

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17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.

19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

Stow Ammunition on an Abrams Tank (Stow Ammo)

The purpose of this task is to determine the relationship between performance of a test designed to simulate lifting and carrying ammunition to an Abrams tank and simple predictor tests. Make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch (check now). Also, make sure your gloves are on.

During this task, you will lift and carry 18 rounds 5 meters from the supply point to the tank and lift it onto a table simulating a soldier on the hull of the tank. While carrying the rounds, one hand should be over the aft-cap while the other is supporting the weight (demonstrate). When lifting the rounds at the table, you should do it in a safe manner. Do not throw them or slam them in the table. You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. If at any point you feel you are unable to continue, the test will be terminated.

Upon completion of the task, you will be asked for your heart rate. You will also be asked to rate your physical effort on a scale from 6 to20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

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19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

Isometric Biceps Curl

The purpose of this task is to determine the ability of an isometric Biceps curl to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will stand holding onto a bar with palms facing up, elbows at a 90° angle and forearms parallel to the floor. I will adjust the instrument to fit you. You will stand with your feet hip width apart without bending your knees or hips. I will give you a "ready-three-two-one-pull," without jerking or leaning back, build up to your maximal force in about 2 seconds, pull for about 3 more seconds and then relax. You will perform the test three times, if you improperly performed the test you will be asked to take a short rest and repeat the attempt. Do you have any questions?

Upright Pull

The purpose of this task is to determine the ability of an upright pull to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will stand with your feet about 50 centimeters apart, and squat down flexing at the knees and hips. You will grasp the handles with the palms facing in opposite direction approximately equidistant from the center of the handle. Then place your buttocks against the wall to the rear, and straighten your back and look straight ahead. I will give you a "ready-three-two-one-pull," without jerking build up to your maximal force in about 2 seconds, maximally pull for about 3 more seconds and then relax. You will perform the test three times, if you improperly performed the test you will be asked to take a short rest and repeat the attempt. Do you have any questions?

Squat Lift

The purpose of this task is to determine the ability of a dumbbell squat test to predict performance of the physically demanding tasks of a Combat Arms Soldier. Beginning with a pair of 25-lb dumbbells, you will squat, grasp handles, and complete a set of three to five squat lifts.

Prior to testing, make sure you are wearing gloves. (Demonstrate while explaining) You will begin by placing feet between the dumbbells about shoulder width apart. Make sure your knees are in line with toes. On the "set" command, bend at the hips and knees, sticking your butt back so that your back is flat or slightly arched. Keep your head up, and grip the dumbbells at your sides with your arms fully extended. When given the "lift" command, lift the dumbbells straight up by extending your knees and hips at the same time. Keep your head angled up. The dumbbells should stay as close to your legs as possible, and your arms should remain extended. When you are standing with your hips and knees fully straight, the test administrator will say "good" and you will squat back down and release the weights in their stands in a safe and controlled manner. If you show poor lifting technique or you drop the weights, we will stop you and you will not receive credit for that lift.

After you have completed the first weight, you will be given a short rest and then you'll be asked to lift a pair of dumbbells 10 lb heavier. The maximum lift for this test is a pair of 110-lb dumbbells for a total load of 220 lb. If you fail to lift a load, you may try one more time after a brief rest.

Don't overexert yourself trying to lift a weight that is too heavy. If you feel any pain or discomfort, you should put the dumbbell down and stop performing the task. Do you have any questions?

Handgrip

The purpose of this task is to determine the ability of handgrip strength to predict performance of the physically demanding tasks of a Combat Arms Soldier. The base of the handle will be set so it rests on the heel of the palm and the handle will rest on the middle of the four fingers. You will then hold it so that your elbow is flexed to 90°, the device is oriented up and down, and your shoulder and wrist are in a relaxed position. When I say go, you will squeeze your hand as tight as possible, while avoiding use of any other part of the body. If I see that you are using other muscles, you will be asked to repeat the measure. You repeat this three times in each hand, alternating hands. Do you have any questions?

Medicine Ball Throw

The purpose of this test is to assess the ability of the Medicine Ball Throw test to predict performance of the physically demanding tasks of a Combat Arms Soldier. During the test, you will sit in the chair with your back against the back rest and both feet on the ground. During throw and follow through your back must stay in contact with the chair. You will hold the medicine ball with both hands. When I say 'go', you will touch the medicine ball to your chest and then push/throw it as far forward as possible. It is recommended that you throw it up at a 45° angle to get maximum distance. The distance between the front of the chair and the landing point of the medicine ball will be measured. You will be given two practice throws. After the practice throws you will be asked to complete three throws for record. While throwing the medicine ball, you must keep your back against the chair. If you fail to maintain contact with the back of the chair you will be asked to repeat the throw. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Standing Long Jump

The purpose of this task is to determine the ability of the standing long jump to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will stand behind the line with your feet slightly apart. You will jump as far as possible with a two foot take-off and landing. You are allowed to swing your arms and bend your knees to provide forward push. If you fall, we will ask you to repeat the attempt. You

will be given two practice jumps and then you will perform three maximal effort jumps that will be recorded. Do you have any questions?

Resistance Pull

The purpose of this test is to assess the ability of the Resistance Pull test to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will be asked to run backwards 20 meters while holding a 24-kg kettlebell attached to a sled/device providing resistance.

You will begin with your back facing the direction you will be running. When ready, you will pick up the kettlebell with two hands side by side, and I will give you a "3, 2, 1, Go" countdown. On the "go" command, run backwards as fast as you can while maintaining your safety. I will let you know when you cross the finish line. Time stops when the sled crosses the line, not your body. If you don't cross the line in 90 seconds, I will give you a "5, 4, 3, 2, 1, stop" countdown. On the "stop" command, stop where you are, and I will measure how far you ran. If you fall during the test, attempt to get up and keep going. If at any point you feel you are unable to continue, the test can be terminated. Do you have any questions?

300 meter Sprint

The purpose of this test is to assess the ability of the 300 meter sprint test to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will start the test with the toes of one foot on the starting line, and the other foot either even with or behind the line. When I say 'go', you will run 300 meters. The test is complete when you cross the finish line. Run the 300 meters as fast as you can, while maintaining safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Powerball Throw

The purpose of this test is to assess the ability of the powerball throw test to predict performance of the physically demanding tasks of a Combat Arms Soldier. During the test, you will be standing with your back facing the direction you will be throwing. Your feet should be shoulder width apart with your heels on the "zero"/ start line.

(Demonstrate while describing motion) You will begin the throw with the ball in both hands, held over your head. While keeping your arms extended, swing the ball down between your legs while flexing your knees, hips and trunk. After you have reached a squatting position, thrust your hips forward, extend your knees and trunk, flex your shoulders, while in one motion, throw the ball back overhead.

You will be given two practice throws. After the practice throws you will be asked to complete three throws for record. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Arm Ergometer

The purpose of this task is to determine the ability of an arm ergometer test to predict performance of the physically demanding tasks of a Combat Arms Soldier. The test involves cranking an arm ergometer, as fast as possible, for 2 minutes. You will kneel in front of the arm ergometer and I will adjust the handles to fit you. After, you will perform ten revolutions to familiarize yourself with the test and to provide a warm-up. When you are ready I will say "ready-three-two-one-GO," you will then have 2 minutes to perform as many revolutions as possible. We will inform you when you are half way, and when you have 30 and 15 seconds left. We will record the number of revolutions at 2 minutes. Do you have any questions?

One Minute Push-Ups

The purpose of this task is to determine the ability of using a 1-minute push-up score to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will begin by assuming a front-leaning rest position by placing your hands shoulder-width apart, with your feet together or up to 12 inches apart. When I say 'go', you should begin the push-up by bending your elbows and lowering your entire body as a single unit until your upper arms are at least parallel to the ground. Then, you should return to the starting position by raising your entire body until your arms are fully extended. At the end of each repetition, the scorer will state the number of push-ups correctly performed. Push-ups in which the arms are not parallel to the ground or the elbows are not fully locked at the end of a repetition will not be scored. You may rest at any time, however during rest breaks your hands and feet must not break contact with the ground. You will have 1 minute to complete as many as possible.

You should perform the task as long as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

One Minute Sit-Ups

The purpose of this task is to determine the ability of using a 1 minute sit-up score to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will begin by lying down in the proper sit-up position. You should be lying on your back with your knees bent at a 90° angle. Place your feet under the tables at the end of the mat. During the test, your fingers must be interlocked behind your head and the backs of your hands must touch the ground. On the command "go" you should begin raising your upper body forward to the vertical position. After reaching the vertical position, you should lower body until the bottom of your shoulder blades touch the

ground. You must use proper sit-up technique for the repetition to count. If you need to rest, you may do so only in the up position without resting your arms on your legs to hold yourself up. You may not rest in the down position. You will have 1 minute to complete as many as possible.

You should perform the task as long as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Beep Test

The purpose of this task is to determine the ability of the beep test to predict performance of the physically demanding tasks of a Combat Arms Soldier. You will jog, run, and then sprint continuously between the two lines 20 meters apart in time to recorded beeps. This test will require that you push yourself to your maximal ability and you should be winded at the end of the test. The audio recording will tell you when to begin. The test start begins with a slow warmup. The beeps will increase in speed every level, which is about every minute. This will be indicated on the audio recording with a different sound. Each shuttle within a level is at the same speed.

You must cross the opposite line before the beep occurs and you cannot leave the line until the beep sounds. If you do not make it to the line before the beep, I will call out your ID number and give you a warning (Example: "352 Warning #1"; "352 Warning #2"). When you miss 3 beeps *in a row*, you will be informed by the investigator that the test is over ("352 you're done!"). At any point, you may choose to stop on your own if you do not feel like you can continue.

After completing, an investigator will ask you to read your heart rate off of your heart rate monitor. Do you have any questions?

Loaded Step Test

The purpose of this task is to determine the ability of a loaded step test to predict performance of the physically demanding tasks of a 12B. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When told to begin, you will step up and down from the step to the beat of the metronome. You will complete an UP, UP, DOWN, DOWN motion (demonstrate and practice) with one foot movement on every beat. You should complete the cycle every four beats.

The test will end after you fail to keep the pace for two consecutive cycles or after a maximum of 5 minutes. I will be asking for your heart rate periodically during the task and for 1 minute after you finish.

You should perform the task as long as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Illinois Agility Test

The purpose of this test is to assess the ability of the Illinois agility test to predict performance of the physically demanding tasks of a Combat Arms Soldier. During this test, you will run through a series of cones. (*Show Soldiers Figure A below, and point out the course as you explain the next section*). You will start the test lying on your stomach with your hands in a push-up position and facing the first far cone. I will give you a "Three-Two-One-Go" and you will sprint the far cone, then sprint back to this middle cone (point to it). Do a zig-zag up and back in the center cones. Sprint to the far cone (point to it) and then sprint back through the finish line (point to it). During the test, run through the course as fast as you can, while maintaining safety and without knocking over the cones. If at any point you feel you are unable to continue, the test will be terminated. If you make a mistake during the test we will ask you to stop and repeat the attempt. Do you have any questions? If you wouldn't mind following me, I will walk you through the course before we begin.

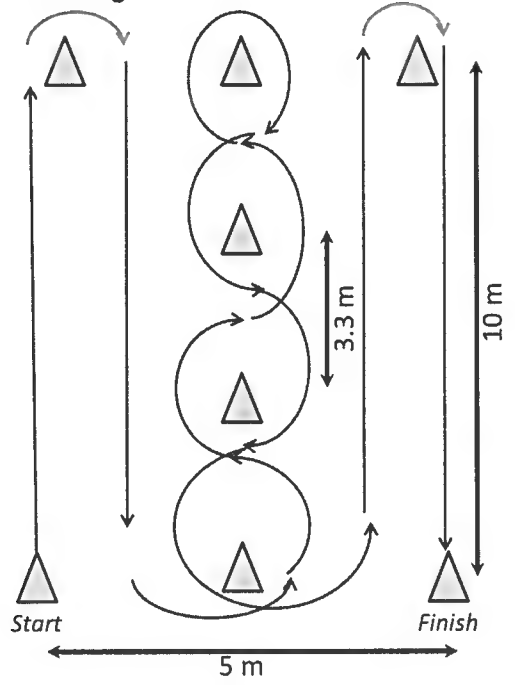
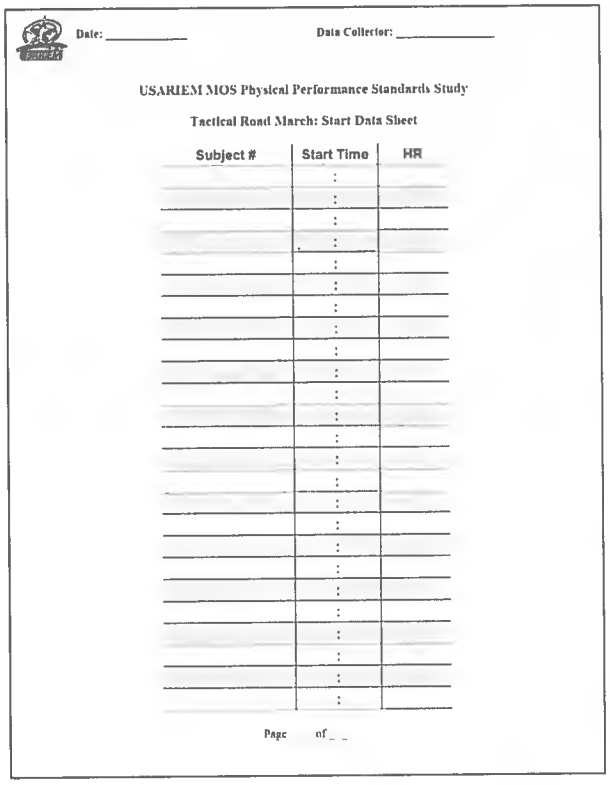


Figure A. Illinois Agility Course Outline

APPENDIX D. DATA COLLECTION SHEETS FOR CMTS AND PREDICTOR TESTS



Date: _____ Data Collector: _____

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Start Data Sheet

Subject #	Start Time	HR
	:	
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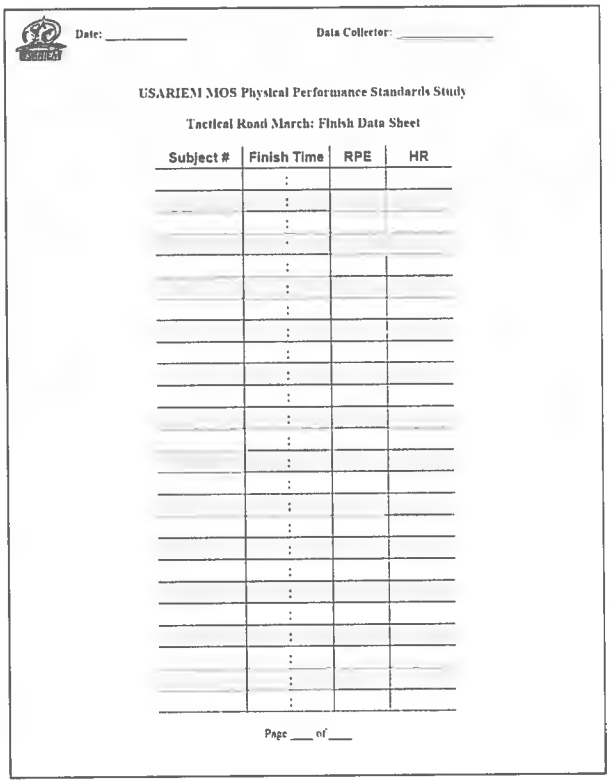
Page ___ of ___



Date: _____ Data Collector: _____

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Finish Data Sheet

Subject #	Finish Time	RPE	HR
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Page ___ of ___

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Start Discomfort Scale

Date: _____ Data Collector: _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Finish Discomfort Scale

Date: _____ Data Collector: _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

Sandbag Carry

Soldier Weight
Fighting Load NO WEAPON **(**

lb): _____

Stopwatch Number: _____ Stopwatch Record #: _____

Time to Finish (Min:Sec)	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*
____ : ____			

STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY ISSUES WITH PRINTOUT BELOW.

Comments:

Move Under Direct Fire

Soldier Weight
Fighting Load WITH WEAPON **(lb): _____**

Stopwatch Number: _____ Stopwatch Record #: _____

	Time to Finish (min:sec)	*RPE (6-20)*	*HR (bpm)*
Baseline			
Finish	:		

Comments:

Casualty Extraction

Soldier Weight
Fighting Load NO WEAPON **(lb):** _____

Rep	*Bag Weight (lb)*	*Completed (Y/N)*	*RPE (0-10)*
1			
2			
3			
4			
5			
6			
7			

Comments:

Casualty Drag

Soldier Weight
Fighting Load WITH WEAPON **(lb):** _____

	Distance (m)	*Time to Finish (sec, up to 60)*	*RPE (0-10)*	*HR (bpm)*
Baseline				
Finish		:		

Comments:

Transfer Ammo with an M992 Carrier Ammunition Tracked (CAT) (30 Rounds)

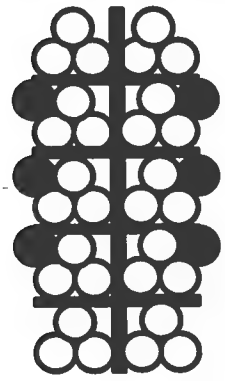
Soldier Weight in *Mission Specific PPE* (lb): _____

Stopwatch Number: _____ Stopwatch Record #: _____

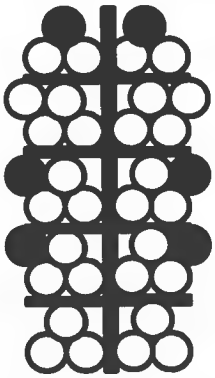
	Time (min:sec) in Shift *Up to 5:00*	*Total* Rounds Completed	RPE (6-20)	HR (bpm)
Baseline				
Shift 1 (0:00-5:00)	:			
Shift 2 (7:30-12:30)	:			
Shift 3 (15:00-20:00)	:			

Mark filling pattern. If all 30 shells not Loaded Mark with an X which slots were filled

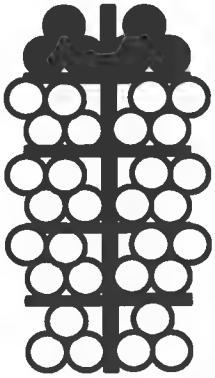
☐ *Filled to Top*



☐ *Second Row*



☐ *Third Row*



STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY COMMENTS OR ISSUES BELOW.

Comments:

Load the 120mm Main Gun on an Abrams Tank (5 Rounds)

Soldier Weight in *Mission Specific PPE* (lb): _____

Stopwatch Number: _____

		Stopwatch Record #	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*HR (bpm)*
Trial 1	**Baseline**				
	Finish		:		
Trial 2	**Baseline**				
	Finish		:		
Trial 3	**Baseline**				
	Finish		:		

STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY ISSUES WITH PRINTOUT BELOW.

Comments:

Stow Ammunition on an Abrams Tank (18 Rounds)

Soldier Weight *Fighting Load Minus WEAPON* (lb): _____

Stopwatch Number: _____ Stopwatch Record #: _____

	Time to Finish (Min:Sec)	*Rounds Moved (#)*	*RPE (6-20)*	*HR (bpm)*
Baseline				
Finish	:			

STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY ISSUES WITH PRINTOUT BELOW.

Comments:

Beep Test

Check as Shuttle Completed

Level #	Shuttle # 1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

Beep Test	***Level #***	***Shuttle #***	***Heart Rate*** *(bpm)*
Baseline			
Finish			

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Medicine Ball Put (cm)					
Illinois Agility (min:sec)	:				

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Upright Pull (lb)					
Isometric Bicep Curl (lb)					

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Standing Broad Jump (m)					
One Minute Push Ups (#)					

Comments:

Resistance Pull Test	*Time* (min:sec)	*Distance (m)* *(if not completed)*	*Heart Rate (bpm)*
Baseline			
Finish *(up to 20 m or 90 sec)*			

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Power Ball Throw (cm)					
One Minute Sit-Ups (#)					

Comments:

Arm Endurance	*Revolutions* (#)	*Heart Rate* (bpm)
Baseline		
Minute 1 (Halfway)		
Minute 2 (Finish)		

				If Necessary	
	Left 1	*Left 2*	*Left 3*	*Left 4*	*Left 5*
Handgrip (kg)					
	Right 1	*Right 2*	*Right 3*	*Right 4*	*Right 5*

Comments:

	Time (min:sec)
300 Meter Run (min:sec)	:

Comments:

Squat Lift (lb)	*Completed (Y/N)*	*RPE (0-10)*
50		
60		
80		
100		
120		
140		
160		
180		
200		
220		

Comments:

Loaded Step Test

Soldier Weight
***Fighting Load WITH WEAPON* (lb):** _____

Time (min:sec)	*Pre Heart Rate*	*Test Period Heart Rate*			
		1 Min	2 Min	3 Min	4 Min
:					
	End Heart Rate	*Post Test Heart Rate*			
		15 Sec	30 Sec	45 Sec	60 Sec

Comments:

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